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ELEMENTS

OF THE

ANATOMY

OF THE

HUMAN BODY

IN ITS SOUND STATE;

WITH

OCCASIONAL REMARKS ON PHYSIOLOGY, PATHOLOGY, AND SURGERY.

BY

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TO

SIR JAMES M^cGRIGOR, M. D.

F. R. S. L. & E.; K. T. S.;

DIRECTOR-GENERAL OF THE ARMY MEDICAL DEPARTMENT, &c. &c. &c.

A Gentleman no less distinguished by his own professional knowledge, and the many improvements he has made in Medical Science, than by the very judicious arrangements which he has introduced into the department of the Army over which he more immediately presides,

THIS VOLUME

IS RESPECTFULLY DEDICATED,

BY HIS SINCERE FRIEND,

THE AUTHOR.

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ELEMENTS

OF

ANATOMY.

PART V.

OF THE ORGANS OF CIRCULATION AND RESPIRATION.

SECTION I.

GENERAL REMARKS ON THE ORGANS OF CIRCULATION AND RESPIRATION.

THE structure of the alimentary canal, and of those organs which assist in digestion, has been noticed on a former occasion *; together with the various changes which the food undergoes in the stomach, and during its long and circuitous route through the intestines.

It has been already explained, in what manner the useless part of the food is discharged from the body; but we have not traced the progress of the chyle, or more useful part of the food, into the blood.

Following the regular progress of the chyle, I should proceed to describe those vessels which take it up from the inner surface of the intestines; and which, from the resemblance of their contents in point of colour to milk, have been called *Lacteal*

* Vol. i. p. 515, &c.

Vessels: but as these vessels constitute a part of the Absorbent system, in order to avoid unnecessary repetition, it is proposed to postpone such description, until the structure and functions of the absorbent system at large shall be explained.

The lacteal vessels convey the chyle into the beginning of a duct, called the Thoracic, which is inserted into the angle formed by the union of the left subclavian and internal jugular veins in the neck. The chyle is therefore mixed with the blood very near to the heart, and speedily passes through the lungs, which is necessary for the incorporation of the recent chyle with the old blood; or in the lungs, the process of digestion is completed.

From the heart, there are canals or *Arteries*, through which the blood is distributed over the body for its growth and nourishment; and there is a reversed system of vessels, called *Veins*, through which the blood flows back to the heart.

The functions of circulation and respiration, have an immediate reference to, and dependence upon each other. The object of the latter is, to produce a change on the blood by the agency of the atmospherical air; and, accordingly, in all animals, the mechanism is such, that a large surface is exposed to the influence of the air.

In the mammalia and birds the air enters, by a tube or tubes, into cellular lungs; and in these animals there are two circulations. The heart is double; one is appropriated to the circulation of blood through the lungs; the other, and stronger heart, is destined to the circulation of the blood through the system at large. But in the oyster and fishes, that receive air with which the water is impregnated, and which passes between the folds of their gills, there is only one heart; and fishes in the egg or spawn, also derive their oxygen from the air that is dissolved in the water.

In some animals, therefore, the heart propels the blood into the lungs and body at large, but, in others, to the lungs only; and, in a third class, as in the flying insects, to the body only. In these last animals the veins carry the blood to the heart, which propels it into the arteries that are diffused over the body.

The air enters the bodies of caterpillars and insects, that are provided with bloodvessels but no heart, by a number of apertures, called Spiracula, which communicate with two air-vessels which extend from the head to the tail: Hence there is no part of the body on which the air does not exert its chemical effects; and when they move, the blood may be seen passing from one extremity to the other, of a tube situated upon the back.

In the class Amphibia, there is a peculiarity of structure, viz. a communication between the ventricles of the heart, in order that these animals may remain under water for some time without a supply of air.

There is a very singular circumstance connected with the admission of the air into the bodies of many insects, which merits mention. During the winter, the spiracula through which the air enters are shut, whereby the animal falls into a torpid state; but upon the return of spring, the air retained within the tubes connected with the spiracula becomes expanded by the heat of the atmosphere, and the orifices of the spiracula are forced open.

The simplest apparatus by which the blood is exposed to the influence of the air, exists in the egg, before the chicken is hatched; the air passing through the porous egg-shell, which is lined by a vascular membrane.

A constant supply of fresh air is not equally necessary to the continuance of the life of every class of animals; for there are some animals that can live without a fresh supply of air longer than others.

The reptiles in general can live for hours without a supply of air.

Leeches live for hours without air, and when covered with oil; and Caridori lately found the same to hold true in respect to land tortoises, which respire by lungs. (Vide Italian Phys. Journal, vol. ix. p. 318.)

The young of animals must receive their portion of air; for the impregnated eggs of insects, and even of fishes, do not produce young, unless they are supplied with air.

Sir Humphry Davy found, that the eggs of moths do not

produce larvæ when confined in pure carbonic acid; and when they were exposed to common air, the oxygen partly disappeared, and carbonic acid was formed.

Oxygen air is also necessary to vegetables.

Seeds, for instance, do not germinate without a supply of oxygen. They do not vegetate in pure carbonic acid, though they swell when moistened, and soon putrefy. Hence the great advantage of exposing seeds to the air, and the cause of the greater fertility of sandy soils,—the atmosphere passing readily through the sand, but not through the adhesive clay.

In short, the admission of the air is necessary to vegetable as well as to animal life.

Respiration, therefore, is one of those functions which has been justly called *Vital*; for to live and breathe are synonymous terms.

Another purpose served by the blood being exposed to the influence of the atmospherical air, is, the completion of the process of digestion.

The chyle, before it become fit for nutrition, must be exposed to the influence of the air. The chyle and blood are not fully incorporated with each other, until they have passed through the lungs or gills; hence, the organs in which this most essential change takes place, are appendages to the circulation.

There is still another appendage to the circulating system, by which the due balance is preserved between the circulating fluid, and the caliber of the bloodvessels; or there is a medium through which that part of the fluid which is mixed with the blood, and is no longer useful, is discharged from the body. Such is the function of the kidneys and uriniferous canal.

SECTION II.

OF THE PARIETES OF THE HUMAN THORAX.

In the more perfect animals, the organs of circulation and respiration are contained within an osseous case, which serves not only as a means of defence, but also has, from its peculiar

construction and mobility, an immediate reference to the function of the lungs.

The thorax has been divided into an anterior part, called the breast; a posterior part, or back; and into lateral portions or sides.

The parietes of the thorax are composed of skin, cellular substance, fat, muscles, bones and membranes.

The upper part of the thorax, during life, seems to be the broader: this is owing to the muscles of the shoulders; whereas, in the well formed skeleton, the under part of the chest is the broader part of it.

In a former part of this work *, the shape, situation and attachments of the ribs, and of their cartilages, have been explained.

The natural form of the chest is occasionally much changed by the operation of external pressure, of organic derangements of the parts contained within it, and by distortion of the spine.

Thus, the female chest is occasionally much contracted and deformed in its lower part, by wearing tight stays, by which the foundation of bad health often is laid; for thus the functions of the stomach, lungs and liver, are deranged. When the spine is distorted, the ribs of one side are brought closer together, and those of the opposite side are proportionally separated from each other; the shoulder is raised, and is broader on the one side, while on the other, it is flat, lower, and contracted: hence the deformed seldom arrive at old age; they soon become asthmatical, or die in early life, from consumption, or water in the chest; as, on account of the diminished capacity of the chest, the blood does not circulate freely through the lungs.

In consequence of rickets, the ribs are still more distorted, together with the spine, which is frequently much bent forwards. This is the more dangerous kind of curvature, as the spinal chord, at the angle, is often much compressed, which leads to palsy of the inferior extremities.

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* Vide vol. i. p. 106

SECTION III.

OF THE SOFTER PARTS CONNECTED WITH THE BONES OF THE CHEST.

Of the Mammæ.

The mammæ, or breasts, are somewhat of a hemispherical shape, and adhere to the anterior part of the greater pectoral muscle, by means of cellular substance.

The breasts of the male are termed Mammillæ.

The size of the breasts is very various at different periods of life. At birth they are large, and equal in size in both sexes; and a small quantity of a mucous fluid may then be squeezed out of them in either sex.

A short time before, or about the period of puberty, they grow rapidly in the female.

At the approach of the menses the breasts enlarge; but, at the cessation of the menses, they shrink.

The mammæ attain a large size towards the latter months of utero-gestation; and, from their weight, become pendulous, while a woman is a nurse; the cellular substance uniting the gland to the pectoral muscle, being much elongated. The mammæ of some savage nations, as the Hottentots, are frequently so long, that the mother can suckle her child whilst she carries it on her back.

The mammæ, in appearance, are white and firm, but irregular in substance, and are composed of glandular follicles, lactiferous ducts, fat, bloodvessels, nerves, and lymphatic vessels.

From the glandular parts of the mammæ, the smaller lactiferous tubes arise, which are united into twelve or sixteen larger tubes, most of which open near to the apex of the conical-shaped projection of the mamma, called its Papilla.

The larger lactiferous ducts diverge through the substance

of the breast, and are from twelve to eighteen in number. The excretory ducts do not communicate with each other.

The lactiferous tubes are coiled up within the cellular substance of the elastic papilla, in such a manner, that the milk does not flow through them until they are extended.

The mammæ are largely supplied with blood from the external and internal mammary arteries, and are also furnished with absorbent vessels.

The papilla of the mamma is surrounded by a dark-coloured line, called Areola, which, during pregnancy, becomes almost black; upon the surface of the papilla there are the orifices of the ducts of glands, which secrete a mucous fluid, in order to prevent excoriation.

The nerves of the mammæ are derived from the axillary plexus.

By the breasts, the milk is secreted, which is intended for the nourishment of the child, for some time after birth.

This secretion begins a short time before delivery; and the milk continues to flow for many months, if the woman suckles her child. There is much difference in different individuals as to the quantity of the milk which is secreted; and even in the same woman, after different pregnancies.

The child, by means of its lips, grasps the nipple, and excludes the external air; it then acts with its tongue, as by the piston of an exhausting syringe: thus the papilla is elongated; the lactiferous ducts within it are stretched out; and the milk, being forced from the breast, by the pressure of the atmosphere, flows into the child's mouth.

The milk of different animals is of different qualities.

The chemists have turned their attention chiefly to the milk of the cow, which is composed of the following ingredients:— Water, Oil, Curd, Extractive, Sugar of Milk, Acetic Acid, Muriate of Soda, Muriate of Potash, Sulphate of Potash, Phosphate of Lime, Phosphate of Magnesia, and Phosphate of Iron.

Woman's milk differs from that of the cow: *First*, In containing less curd; *second*, Its oil is so intimately combined

with its curd, that it does not yield butter; *third*, It contains rather more sugar of milk.

Parmentier and Deyeux * ascertained, that the quantity of curd in the milk of women increases in proportion to the time after delivery.

SECTION IV.

OF THE MUSCLES OF THE THORAX WHICH ARE SUBSERVIENT TO RESPIRATION.

The muscles by which respiration is performed, constitute a part of the parietes of the thorax. The lungs during respiration are passive, and follow the movements of the chest: they have not unaptly been compared to a pair of bellows containing an empty bladder, the neck of which is so adapted to the boards of the bellows, as to admit the air, on the boards being separated from each other.

The muscles by which respiration is performed belong to that class of muscles which have been called *mixed;* as we can retard, accelerate, or stop, for a short time only, the action of these muscles.

To expose the muscles covering the fore-part of the thorax, an incision should be made through the skin, in the direction of the breast-bone, and extended obliquely outwards, along each of the clavicles. Upon raising up the skin, cellular substance, fat and mammæ; the *greater pectoral muscles*, covered by a thin tendinous aponeurosis, and at their upper part by the thin muscle called Platysma Myoides, come into view.

The fibres of the *pectoral muscle*, which arise from the cartilages of the fifth and sixth ribs and clavicle, converge, and form a stronge tendon, which is fixed into the os humeri. On the fore part of the pectoral muscle, there are several small branches of the internal mammary arteries, which come through the interstices between the ribs. On the lower edge

* Journal de Phys. xxxviii. p. 422.

of the pectoral muscle, the extremities of the long thoracic arteries are distributed.

Under the greater, the *lesser pectoral muscle* is situated.

The sides of the thorax are covered by the serrated muscle, called *serratus anticus major*.

Upon removing the *serratus anticus major*, the oblique muscular fibres between the ribs, called *intercostal muscles*, come into view.

When the muscles of the thorax have been removed, the student should attend to the oblique direction of the ribs in respect to the spine; and that, upon the ribs being raised, their cartilages are twisted: hence, when the force is removed by which the ribs were elevated, they regain their original situation, in consequence of the elastic reaction of their cartilages, which fix them to the breast-bone, or to each other.

Of the Muscles by which Inspiration is accomplished.

The muscles more immediately concerned in inspiration are, the *intercostal muscles* and *diaphragm*.

Of the Intercostal Muscles.

There are two strata of intercostal muscles, which are oblique muscles, and have their fibres crossing each other. The *external stratum* arises from the under edge of each rib, excepting the twelfth; runs obliquely downwards and forwards from the spine to the union of the ribs with their cartilages, and is fixed into the upper edge of each rib.

There are portions of the external intercostal muscles which arise from the transverse processes of the vertebræ, and have been named *levatores costarum breviores et longiores*.

The origin of the *internal intercostal muscles* is similar to that of the external. They run downwards and backwards, crossing the former stratum, and are continued as far as the angles of the ribs.

The external stratum is not found between the cartilages of the ribs and the breast-bone; nor the internal stratum between the angles of the ribs and spine.

My Father discovered, that both strata are subservient to

the elevation of the ribs, and, speaking of this subject, has observed:

"The chief circumstances which prove, beyond a doubt, that the two rows of intercostal muscles conspire in elevating the ribs, are,

"1. That the first rib is so much fixed at both its ends as to be almost immoveable; and its cartilage, instead of being connected to the sternum by a capsular ligament, or articulated with it in the same manner as the cartilages of the other ribs, grows as firmly to the sternum as to the rib.

"2. That the second rib is more fixed than the third; and the third more fixed than the fourth; and so on downwards.

"3. That as the ribs, from the first rib downwards, grow gradually longer, and describe portions of larger circles, we may observe that, in general, or when we examine a middle proportion of the intercostal muscles, or a portion half way between the sternum and vertebræ, the insertion of the lower end of the portion is at a greater distance from either end of the lower rib, or from a straight line drawn between the two ends of that rib, than its origin in the rib above is from the two ends of that rib, or from a straight line drawn between them. Hence whether we consider the head of the rib, connected with the vertebræ, as its centre of motion, or whether we consider the rib as moving upon a straight line or axis drawn between its two ends, it follows, that a muscle placed between two ribs acts with a longer lever upon the under rib than upon the upper one, and therefore must elevate the under rib.

"4. To determine the effect of the contraction of any muscle, I apprehend, we need only to observe in the dead body what the situation is in which the muscle in question is relaxed. Applying this rule, we shall find, that the whole intercostal muscles, internal as well as external, are shortened when we elevate the ribs, and place them in that situation in which we find they are in inspiration.

"5. If the internal intercostal muscles had been intended

for the depression of the ribs, we certainly should not have found them continued to the sternum, because their anterior ends are fixed above to the edge of the sternum, or so near to the insertion of the cartilage of the upper rib in the sternum; and their inferior ends are, in consequence of their obliquity, fixed to the under rib so much farther from the sternum, that they must act upon the under rib with more advantage of lever, or are intended for its elevation.

" On the other hand, if the internal intercostals had been intended for the depression of the ribs, we certainly should have found them continued backwards to the spine; because, from their obliquity, their under end would have been fixed to the vertebræ, or nearer to the head of the rib, and their upper end at such a distance from it, that this portion of the muscle would have been better calculated than any other portion of it for the depression of the rib.

" 6. In a few experiments which I made on living animals, soon after I began to study anatomy, and which I repeated afterwards, particularly in 1770, I saw plainly that both rows of intercostal muscles were in action during inspiration.

" Let us now consider the purpose,

" *First*, Of the obliquity of the fibres in the intercostal muscles; and,

" *Secondly*, Of their being disposed in two layers, the fibres of which decussate each other.

" It is evident, that the obliquity of the fibres here is not intended to increase their number, or the strength of the muscle, because the fibres would have been more numerous if they had passed directly from the one rib to the other, or had been inserted into the ribs at right angles.

" I apprehend, therefore, that we are to explain the reasons of the structure in the following manner:

" Nature, in order to give protection to the heart and lungs, has formed the ribs as broad and flat as possible, or left no more space between them than is required for lodging muscles for their motion in respiration. Consistently with this view, as the ribs are fixed at both ends, so that they cannot be moved backwards and forwards, but are confined to mo-

tion upwards and downwards, remaining nearly parallel to each other, oblique muscles are preferred to straight; for if the former can, as I have before demonstrated, perform more extensive motion than the latter, even where both are of the same length, they must have a still greater effect, where the two kinds of muscles are confined between the same parallels.

"Thus, suppose the direct distance, or perpendicular drawn from one rib to another, to be represented by three parts; and that the intercostal muscle, in consequence of its obliquity, measures five such parts; and that each of these is capable, when in action, of shortening itself one-fifth part of its length; it appears from the demonstration, that the oblique muscle can move the rib through a space five times greater than the straight muscle can do.

"On accurate mensuration, I found the length of the intercostal muscle to be one inch and a half, the perpendicular line one inch, and the base about one and one-eighth inch. Hence, calculating on the supposition, that the muscular fibre, in action, shortens itself one-fifth of its length, it will be found, that the intercostal muscles, in consequence of their obliquity, produce a greater motion of the ribs than perpendicular muscles could have done, nearly in the proportion of 35 to 12.

"The only point remaining to be explained, is, why Nature hath formed two layers of intercostal muscles decussating each other.

"The purpose of this, I apprehend, is to render the motion of the rib upwards as direct as possible, and to prevent it from being drawn or pressed forwards upon the sternum, or backwards upon the vertebræ, so much as, by its friction, to interrupt the freedom of its motion.

"Upon the whole, by the obliquity of the intercostal muscles, the motion of the ribs is very much greater than could have been performed by straight muscles placed between them. At the same time, by their consisting of two layers, or two muscles decussating and balancing each other, the motion of the ribs, upwards and downwards, is as direct,

and with as little friction, as if it had been performed by straight or perpendicular muscles."

Of the Diaphragm, and of the powers by which expiration is performed.

This muscle forms the partition between the thorax and abdomen.

This muscle is convex towards the thorax during expiration, and concave towards the abdomen. It is composed of two distinct muscles, called *the Larger or Upper*, and *the Under or Smaller Diaphragm*. The larger diaphragm takes its rise from the ensiform cartilage, from the cartilages of the seventh and lower ribs on both sides; and the fleshy fibres meet in a central tendon, which somewhat resembles the heart in figure. On the right side of this central tendon, there is an aperture for the vena cava inferior. The edges of this foramen are rounded and tendinous, therefore, there is no risk of the blood being impeded in its progress to the heart through the vena cava inferior. There is in some individuals a small fissure in the dirphragm, which is filled by fat and cellular membrane. When this fissure has attained a considerable bulk, a portion of the transverse arch of the colon sometimes passes through it, and is strangulated, which proves the cause of death *. This muscle is covered next the chest by the pleura, and next the abdomen by the peritonæum.

The smaller diaphragm takes its rise by four crura of unequal length. The longer crura arise from the fore-part of the fourth lumbar vertebra, and adhere to all the vertebræ of the loins, by means of a strong ligament. Between these crura, there is an oval-shaped aperture for the aorta, thoracic duct, and great splanchnic nerve.

The muscular fibres of the several origins of this muscle ascend, and in the middle unite, so as to form two fleshy columns, which cross each other; and between these the gullet

* Vide a case of this kind described in my Morbid Anatomy of the Gullet, Stomach, &c. p. 540, &c.

is placed. This smaller muscle, also, is fixed into the central cordiform tendon. The larger and smaller diaphragm are powerful muscles in respiration, and several other actions.

During inspiration, the capacity of the thorax is increased in three different directions. By the descent of the lateral muscular portions of the diaphragm, and by the ascent of the ribs, which are placed obliquely in respect to the spine, the thorax is rendered longer: By the ribs being thrust outwards during their ascent, the transverse diameter of the chest is increased; and, in consequence of the breast-bone being thrust forwards during the elevation of the ribs, the thorax is rendered deeper, and the distance between the breast-bone and vertebræ becomes greater.

The effect of the contraction of the diaphragm and intercostal muscles being understood, it is easy to see what happens during expiration. After a short space, we grow uneasy from the distention of the lungs, and expiration becomes necessary. But when we expire we act with less muscular power, the elasticity of the cartilages of the ribs assisting very greatly in replacing them.

When we lie in a horizontal posture, as soon as we cease from acting with the diaphragm, the very weight of the abdominal viscera, distended with rarified air, does somewhat to replace the diaphragm.

In short, expiration is performed chiefly by the elastic reaction of the cartilages of the ribs, which had been twisted and elevated during inspiration, and by the abdominal muscles.

When the diaphragm descends, it pushes outwards the bowels of the abdomen, and, as soon as the diaphragm is relaxed, we push in the abdominal contents, and replace the diaphragm by that means; and as the external and internal oblique muscles of the abdomen are connected to the edges of the ribs, these are drawn down at the same time.

Some other muscles assist in respiration, as the *triangularis sterni*, which serves to pull down the ribs; and we find at the roots of the ribs *two serrati muscles*, one at the upper part, serving to raise and fix the ribs, and the other at the

under part, serving to pull down the undermost ribs. There are other muscles which occasionally assist in performing inspiration and expiration; these are,

The Serratus Posticus Superior, which takes its origin from the three lowest vertebræ of the neck, and two uppermost of the back, and is fixed into the 2d, 3d, 4th and 5th ribs.

By this muscle the capacity of the thorax is increased, in consequence of the ribs being raised.

The Serratus Posticus Inferior arises in common with the latissimus dorsi by a broad tendon, from the spinous processes of the two lowest dorsal vertebræ, and from the three uppermost lumbar vertebræ, and is fixed into the lower edges of the four inferior ribs.

This is the antagonist of the former, or is a muscle of expiration, as it tends to depress the ribs.

The scaleni are also muscles of inspiration, as they raise the ribs.

The Scalenus Anticus takes its rise from the transverse processes of the 4th, 5th and 6th cervical vertebræ, and is fixed into the upper part of the first rib.

The Scalenus Medius arises from the transverse processes of all the vertebræ of the neck, and is fixed into the upper and outer part of the first rib.

The Scalenus Posticus take its rise from the transverse processes of the 5th and 6th cervical vertebræ, and is fixed into the upper edge of the second rib.

Respiration may be performed by the intercostal muscles only, or by the diaphragm only.

When the descent of the diaphragm is impeded by the unusual bulk of the bowels of the belly or pelvis, as during the latter months of pregnancy, or when the peritonæum is inflamed, the breathing is carried on by the action of the intercostal muscles chiefly. On the other hand, the diaphragm is the principal agent in respiration when the ribs are broken, or when their motion is rendered painful by an inflammation of the pleura; when their cartilages become rigid, or are reduced to a state of bone, as frequently happens during old

age; or when the spinal marrow has been divided between the last cervical and first dorsal vertebra, which renders the intercostal muscles paralytic.

As the action of the diaphragm depends upon the phrenic nerve, which is connected with the third and fourth cervical nerves, it follows, that an injury done to the spine above the origin of the phrenic nerve must occasion great difficulty of breathing, and, in a short time, the death of the patient.

I have had occasion to meet with two instances in which death had been occasioned by an enlargement of the dentiform process of the second vertebra of the neck, and, it may be proper to add, that in one of these cases the difficulty of breathing was supposed to have originated from an inflammation of the lungs.

The muscles of respiration are not easily fatigued, like the muscles of voluntary motion, unless when the breathing is performed with unusual rapidity, as during violent exercise, when the blood circulates with unusual rapidity, and must pass quickly through the lungs.

In running, the breathing is occasionally interrupted. On some occasions, in consequence of violent and excessive exercise, the breathing is suspended; and there are instances of sudden death in consequence of very violent exertion.

It may be also observed, that many hysterical women experience a sense of lassitude in the muscles of respiration, after a hysterical fit.

Upon removing the intercostal muscles, the Pleura, a serous membrane, which is, in all respects, similar to the peritonæum, and which lines the ribs, comes into view. It seems to be opaque, and of a whitish colour; but, upon being punctured, which admits the air into the chest, it appears to be transparent. Before the admission of the air, the pleura lining the ribs, and that forming the external covering of the lungs, are in contact; but, after the air has been admitted into the chest, the lungs collapse, and hence the transparent appearance of the pleura *.

* Vide further proofs of the contiguity of the Pleura Costalis and Pleura Pulmonalis, in my Grandfather's works, pages 659 and 660.

Some time ago, an opinion prevailed, that there was a vacant space between the lungs and the pleura costalis, which led my Father to examine into this fact with attention, and to publish a paper in the Edinburgh Physical Essays, to prove that *the lungs are contiguous to their parietes.*

SECTION V.

OF THE SITUATION AND CONNECTION OF THE VISCERA OF THE THORAX.

The contents of the thorax may be exposed by dividing the cartilages connecting the ribs to the breast-bone on each side, (by which the sterno-costales muscles are brought into view, extending between the middle of the breast-bone and the third, fourth, and fifth ribs), and then, by raising the breast-bone, having previously cut the connection between it and the diaphragm.

While raising the sternum, the two layers of pleura, which form the mediastinum anterius, are distinctly seen: also the triangular cavity between them, opposite to the upper part of the breast-bone, within which the thymus gland, enveloped in a small quantity of fat and cellular substance, is situated.

The thorax is lined, and its contents are covered, connected, and supported, by the pleuræ,—serous membranes, which are, in all respects, similar to the peritonæum. The pleuræ line the ribs and intercostal muscles, and form sacs for the lungs, of a conical form, which are placed obliquely in respect to each other, and the right is the shorter and broader. The lungs are placed side by side, and do not communicate with each other: hence water, air, pus, or blood, does not pass from one side to the other; and the lungs of opposite sides being independent of each other, respiration may be continued though the lung of one side has been destroyed.

These sacs, which contain the lungs, being nearly in opposition, form the partition of the chest called *Mediastinum*

Anterius, which is connected to the sternum and cartilages of the ribs of the left side of the chest; and hence the chest is divided into two cavities of unequal size.

The right and left lungs are not exactly equal in length and breadth; the right being broader than the left, and also shorter; for the right side of the diaphragm rises higher up into the thorax than the left.

The pleuræ which form the mediastinum anterius, are not in immediate contact with each other; for, at the upper part of the sternum, the thymus, and a few lymphatic glands, with cellular substance, are interposed between its component layers, and below, the heart, and the great bloodvessels included within the pericardium are interposed.

The pleuræ, after forming the mediastinum anterius, as above described, are again united, and afterwards separated, to form the *Mediastinum Posterius;* a triangular space (improperly called *cavity* by most authors), in which the aorta, vena azygos, gullet, lymphatic glands, the eighth pair of nerves, the lower end of the trachea and bronchi, are contained.

The pleuræ are reflected from the posterior mediastinum to cover the heads of the ribs, the lymphatic vessels, nerves, and their ganglia.

Upon the air being admitted into the chest through the parietes, the lungs, which were in contact with their parietes, immediately collapse; and, from having collapsed in an equable manner, exhibit an exact miniature of the form of the chest. Between the lobes of the left lungs the capsule of the heart is placed, which is fixed not only to the anterior mediastinum, but also to the middle cordiform tendon of the diaphragm.

From the preceding description of the course of the pleura, it follows,

1*st*, That the pleura, a serous membrane, like to the peritonæum, lining the parietes of the chest, is the bond of union between the included bowels, to which it gives a partial covering; and, being constantly besmeared by a serous fluid, the included bowels do not suffer from the effects of friction.

2*d*, That the heart and lungs are so situated, and so connected, that the contractions of the heart cannot interfere with the play of the lungs, nor can the play of the lungs impede the action of the heart.

3*d*, That as the pleura costalis and pulmonalis are, in the healthy state, always in contact, excepting when the lungs collapse, hence they fill the sacs of the pleura, and correspond in form with the thorax.

4*th*, That the movements of the parietes of the chest and lungs correspond with each other, and that the air will enter or pass out of the lungs as the chest is enlarged or contracted.

5*th*, That the lungs are contained in distinct capsules, which have no communication with each other: hence the lungs of opposite sides of the chest are independent of each other; and, as the mediastinum anterius intervenes between them, they cannot press on each other when we lie on either side, excepting when a large quantity of water or purulent matter, accumulated within one of the sacs of the pleura, may, when the patient lies on the sound side, by pressing the mediastinum to the opposite side, and upon the sound lungs, give rise to considerable difficulty in breathing.

6*th*, That the elasticity of the mediastinum may somewhat contribute to the drawing down of the ribs.

7*th*, That the contents of the mediastinum posterius cannot be compressed by the weight of the superincumbent parts.

8*th*, That when air has got out from the left lungs, in consequence of their having been wounded by a broken rib, or in consequence of a rupture of their substance, if air be diffused extensively in the subcutaneous cellular substance of the chest, it is often difficult to determine whether the air has been diffused into the right or left pleura. If an operation is to be performed for the relief of the patient, an error on the part of the surgeon may prove fatal; for, as the left lung will be already in a state of collapse; if a puncture be made into the right side of the chest, the patient must die (providing there be no unnatural adhesion of the lungs to the side), in consequence of a collapse of the lungs of both sides.

10*th*, That the operation for the discharge of matter should be performed so that the air cannot afterwards be freely admitted, as the admission of the air at the wound during inspiration has sometimes occasioned death: hence the incision of the skin should not be opposite to the wound in the deeper parts. This may be readily avoided by drawing up the skin as far as is possible, before dividing it. The opening should be made between the sixth and seventh, or between the seventh and eighth ribs, and about half way between the spine and breast-bone: for, if the cut be made farther behind, thick muscles are divided; if farther forwards, it is too near the bend of the diaphragm on the right side, and we get too much opposite to the pericardium on the left side.

SECTION VI.

OF THE PERICARDIUM.

The pericardium or capsule of the heart is commonly said to contain that organ, but it is, strictly speaking, on the outer side of it, as that capsule is composed of two distinct membranes, the outer of which is the pleura, continued from the anterior mediastinum; and the internal, the other fibrous lamina, is a membrane, which is reflected over the origins of the great bloodvessels, to form the external covering of the heart itself.

This capsule is loose around the heart, and so capacious as to be capable of containing the heart, though all its cavities were filled at the same moment with blood, which never happens during life; hence the heart readily moves with the pericardium, and adapts itself, in some respects, to the situation of the body.

This capsule has been described as resembling, in form, a cone, but the simile is not quite accurate; for it is considerably contracted at its base, called its *Cornua*, which embrace the large vessels which enter or come out of the heart; it is expanded unequally on the right side of the breast-bone; and it is somewhat like a funnel, where it is opposite to the point of the heart.

The pericardium is firmly supported, in its place, by its

outer coat; it also adheres, by numerous bands of cellular membrane, to the inner side of the breast-bone, to the central cordiform tendon, and muscular part of the diaphragm, on the left side, opposite to the cartilages of the fifth and sixth ribs, at which place there is, generally, a considerable quantity of fat and cellular substance.

The pericardium is also supported by the mediastinum anterius; hence the bloodvessels going into, or coming out from the heart, cannot be elongated and continued in their diameter, and, from the same cause, the heart cannot so readily compress the lungs, if it be not enlarged.

The pericardium is rough externally, where it is connected to the sternum, pleura, and diaphragm, and covered frequently by portions of fat; but internally it is remarkably smooth, and lubricated by a serous fluid, which has been analysed by Dr Bostock. According to that author, 100 parts contain

Of Water	-	92.0
Albumen	-	5.5
Mucus	-	2.0
Muriate of Soda		0.5

The liquor pericardii, which is poured out by invisible orifices, prevents the bad effects of friction.

Though the pericardium possesses a considerable share of firmness, yet it admits of considerable distention, as is evident when water has been accumulated within it; in which case, the pulsations of the heart are felt between the seventh and eighth ribs, instead of between the fifth and sixth ribs, and sometimes even on the right side of the chest.

Water accumulated within the pericardium produces difficult breathing, and impedes the circulation in particular situations of the body.

In this disease, there is also difficulty in feeling the pulse, when the patient lies on his right side, which is owing to the water pressing on the heart, and forming a column between it and the intercostal muscles; but when the patient lies on his left side, there is less difficulty, the apex of the heart approaching nearer to the side. When there is an adhesion of

the heart to the pericardium, its pulsations are felt with difficulty in any position, its motion being much confined.

The pericardium receives its blood from the smaller branches of the internal mammary, phrenic, and œsophagean arteries, and these are accompanied by corresponding veins.

Veins have not as yet been traced into the substance of the pericardium. There are also absorbent vessels proper to the pericardium.

Dr Baillie has described an instance in which the pericardium was awanting.

SECTION VII.

OF THE BLOOD.

Before proceeding to describe the heart, it is necessary to make a few remarks upon the blood.

The human blood is an adhesive fluid, of a red colour in the animals that have vertebræ; has a soapy feel, a salt taste, and emits a watery halitus; its specific gravity is about 1.0527, according to Haller.

In crustaceous animals, as the lobster and shrimp, the blood is white, and in the grasshopper, of a green hue.

Where blood recently drawn, and mixed with water, is exposed to a microscope, it is found to be composed of a watery part, and of particles deeply coloured, called the *Globules*, for the colour is not equally diffused. The globules, according to Mr Hewson, are involved in capsules or vesicles. The form of these globules is not uniform in all animals; in some they are oval, in others rounded.

The globules vary also as to size, according to different observers, even in blood drawn from the same animal, and still more in different animals, and are not proportioned to the size of the animal, being larger in man than in an ox. According to the recent observations of Captain Kater and Mr Bauer, they vary between $\frac{1}{1700}$ and $\frac{1}{3000}$ part of an inch in diameter.

When blood has been allowed to remain at rest, it soon coagulates into a solid mass, of the consistence of curd; which separates itself into two parts, *the serum* and *the cruor*. The

proportions of the serum and cruor differ in different animals; in common, there are three parts of cruor to one of serum.

The coagulation of the blood takes place in the open air, and in close vessels; whether the blood be allowed to cool, or be kept at the temperature at which it is when it flows from a vein; facts which I believe were first ascertained by my Father.

During the coagulation, a sensible quantity of heat is evolved. If, before coagulation has taken place, the blood be placed under the exhausted receiver of an air-pump, air-bubbles are disengaged, according to Darwin, and which, according to Vogel, are carbonic acid. Dr Duncan *jun.* made an experiment lately, which, in my opinion, proves, that no air is extricated during the coagulation of blood exposed to the pressure of the atmosphere. He opened a vein of the arm, filled a Florence flask with blood, which he inverted over a dish full of blood. The blood within the flask coagulated in the usual time, but no air was found in the upper part of the vessel.

Of the Serum.

The serum is of a light green-colour; and its mean specific gravity is about 1.0287. When heated to the temperature of 156°, it coagulates: it has then a greyish-colour, and somewhat resembles the boiled white of an egg; and from the coagulated serum the more watery part may be pressed out. Alcohol, acids and tan, and, according to Mr Brande, the negative wire in the interrupted galvanic pile, coagulate albumen.

If coagulated serum be heated in a silver vessel, the surface of the silver becomes black: hence serum contains sulphur; and, according to Proust, the sulphur is combined with ammonia, in the state of a hydro-sulphuret.

The serum of the blood also contains *Soda*. That portion of fluid which remains after coagulating albumen, has been called the *Serosity*.

Mr Bauer lately detected globules in the serum, and saw them generated in the fluid he was examining: these are quite different from the red globules.

1000 grains of serum of blood contain, according to Dr Marcet *,

Water,	900
Albumen (dry),	86.8
Muco-extractive matter,	4.0
Muriate of soda, with some muriate of potash,	6.6
Subcarbonate of soda,	1.65
Sulphate of potash,	0.35
Phosphates of lime, iron, and magnesia,	0.60
	1000.00

According to some very late experiments of Prevost and Dumas, the blood is essentially composed of serum, holding in suspension the red globules, which are contained in their proper vesicles. When blood has been drawn, the central globules are attracted together, and arrange themselves in lines or fibres, by which the basis of the clot is formed. A quantity of the serum, and of the colouring matter, are entangled in the net-work formed by these fibres, which, by draining, may be separated from them.

They have observed, that the colouring matter is a compound of a peculiar animal substance, (the nature of which they have not particularly examined), and of the peroxide of iron.

It may be proper to add, that Berzelius considers the fibrin and red globules as distinct proximate principles.

Of the Cruor.

The cruor, or clot, is of a red colour, and its mean specific gravity is about 1.245 according to Jurin.

The cruor, by being well washed, is in part dissolved, and a part remains upon the searce. Thus it may be separated into two parts; into a white, elastic, and solid substance, possessing the properties of *fibrin;* and the portion held in solution, which contains the colouring principle.

* Phil. Trans. for 1819.

Many experiments have been made upon the watery solution, which, according to BUQUET, contains albumen and iron.

Soda is also contained in the watery solution; for it gives a green colour to the syrup of violets.

Dr WELLS * endeavoured to prove, that the colouring principle of the blood was of an animal nature. Soon after FOURCROY and VAUQUELIN † made experiments upon the same subject, and imputed the colour of blood to a subphosphate of iron; which opinion has very lately been contradicted by Mr BRANDE, who has adopted Dr WELLS's opinion, and has concluded that the colouring substance is of an animal nature, and, like many other animal colouring matters, may be employed in dyeing.

His words are: "There can, I think, be little doubt that the formation of the colouring matter of the blood is connected with the removal of a portion of carbon and hydrogen from that fluid, and that its various tints are dependent upon such modifications of animal matter, and not, as some have assumed, upon the different states of oxidisement of the iron, which it has been supposed to contain."

SECTION VIII.

OF THE STRUCTURE OF THE HEART.

THE heart is not essential to the circulation of the blood; it is not common to all animals, and even in those animals that are usually provided with a heart, the circulation may be carried on without it, and the animal be well nourished.

The form, size, and structure of the heart vary in different classes of animals; there is no part of their structure which exhibits a greater variety or a nicer adaptation to a peculiar economy.

"The wisdom of the Creator," says HAMBURGHER, "is in nothing seen more gloriously than in the heart."

The heart is a hollow muscle of a conical form, situated

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* Philosoph. Trans. for 1797. † Syst. des Conn. Chim. tom. 8.

‡ NICHOLSON'S Journal, vol. xiv.

within the chest, laid rather more obliquely across it, and well protected by the bones of the chest, by its capsule, and by the soft and spongy lungs, which, to a certain extent, inclose it. It is retained in its place by the great vessels connected with it.

Though the heart is fixed down above and behind, by the large vessels which enter or come out from it, the situation of the heart varies with that of the body. When we lie on the back it falls backwards, on account of its weight, and inclines either to the right or left sides with the body at large; and it is pressed upwards by the distended stomach. The situation of the heart is also altered, by tumours, water or purulent matter collected within the pleura or abdomen. The heart, instead of being laid obliquely, is sometimes placed like the heart of a quadruped, in a line with the breast-bone; and occasionally, though rarely, it is protruded externally, so as to form a hernia.

Chaussier gives a case in which the heart was placed at the upper and anterior part of the abdomen of a new born child. In this case, the form and alternate elevations or depressions of the heart, depending on the dilatation and contraction of its ventricles, were evident to sight. When the child inspired, the heart rose, and partly disappeared, in the thorax; but when it expired, the position of the organ was lowered and more advanced. When the child cried, the size of the tumour was increased, and it became more tense, but the tumour diminished and became softer, when the child was still, and laid on the back, or nearly on the side. On pressure being applied, the heart seemed to re-enter the thorax, and upon the pressure being taken off, the tumour resumed its usual form, and the heart suddenly started forwards. The child was in other respects well made.

Other cases where the heart protruded are on record. Vanbonais * has described a human fœtus, born at the eighth month, where the heart protruded by an opening at the upper part of the thorax.

* Acad. des Scien. 1715.

Tourtelle * saw at Besançon a child with an opening in the lower part of the chest, through which the heart protruded nearly to the navel.

In all the above cases, where the heart was exposed, the individuals died soon after birth; but when the heart was covered, life continued.

Ramel † has described a case of a girl, nine years of age, in which the heart was situated in the epigastric region; and I have met with one instance in which the heart lay on the outer side of the ribs.

There are some instances in which the heart was situated in the abdomen.

Mr Wilson has described an instance, in which the heart was imbedded within the substance of the liver, and it was found to consist of one auricle and one ventricle only. Baudeloque examined the body of an infant, in which there were two distinct hearts; the one situated in the abdomen, the other in the thorax; and there were vessels passing between them. The infant died soon after birth.

The size of the heart varies very much in different individuals, and still more at different periods of life; generally speaking, the younger the individual the larger the heart in proportion to the rest of the body. In general, the size of the heart bears a ratio to the size of the individual, being proportionally larger in the tall and robust male than in the shorter and more delicate female. But the above remark is liable to many exceptions; and it may be also remarked, that the strength of the pulse is not an index to the size or thickness of the muscular walls of the heart.

The human heart is a hollow muscle, somewhat of a conical form, and when its cavities have been filled, it resembles in shape the half of a cone or half of a sugar-loaf.

The upper and anterior surface of the eart is convex, and is opposite to the breast-bone and cartilages of the ribs; but the posterior surface is flat, and lies upon the tendon of the diaphragm. In the upper surface of the heart, there is usual-

* Journ. de Med. tom. lxii. † Ibid. tom. xlix.

ly a white spot about the size of a shilling, and a longitudinal fissure, passing nearly in the axis of the breast-bone, in which the right coronary artery, and a few very small branches of the eighth pair of nerves, are lodged; and, in the inferior flat surface, there is also a groove, in which the left coronary artery and a large vein are imbedded.

The right side of the heart is considerably thinner than the left; the former has hence been called by HALLER the Margo acutus, and the latter Margo obtusus.

The heart is covered by a fine and transparent portion of the pleura, which is reflected from the pericardium, the surface of which has a shining appearance, owing to the serous fluid with which it is constantly besmeared.

Under this membrane there is a greater or less quantity of fat. Even in the leanest persons there is a good deal of fat towards the point of the heart, and some also at the basis of the heart, and in the course of the coronary arteries.

In many instances, and even in old persons, a thin layer of fat covers the whole of the external surfaces of the ventricles.

In very corpulent persons, I have seen so much fat collected upon the surface of the heart, that it seemed to disturb the functions of that organ; and I have also observed, that those persons had, before death, constant palpitation at the heart, even where no organic derangement existed in any part of this organ. On the other hand, there is no fat upon any part of the heart of the fœtus.

Upon the above thin serous membrane and fat, which cover the heart, being removed, the muscular fibres of that organ are brought into view: these are by no means so large as in those muscles which are under the power of the will.

The muscular fibres of the heart are small, numerous, intimately interwoven with each other, and there is no cellular substance between them: it is therefore difficult to trace their course; besides, several fibres take their rise from, and terminate in, the parietes of the particular cavities of the heart.

The greater number of the external stratum of muscular

fibres of the human heart take their origin from the ventro-auricular opening, and from that origin pass obliquely downwards and forwards from the right to the left ventricle. Those fibres which surround the ventricles, reach the apex of the heart, and are reflected around it.

Within the thin external stratum there are transverse fibres having a similar origin. Several of these are folded inwards to form the partition of the heart, the greater part of which is formed by the continuation of the muscular fibres of the posterior ventricle; and these fibres, after winding around the heart, terminate in the columnæ carneæ.

In the transverse section of the ventricles, the fibres are so disposed, that the heart seems to be composed of three distinct bags, one of which contains the other two,—the anterior ventricle, and the posterior or rounder ventricle.

The muscular fibres of the posterior ventricle are disposed somewhat like the worm of a cork-screw *.

By the contraction of the muscular fibres of the ventricles, the opposite sides of the ventricles approach each other, and the apex is drawn nearer to the basis.

In consequence of the very remarkable disposition of these oblique muscular fibres of the heart, the fibres are nearly one-fourth part longer than the distance between their origin and their termination, and (as Sir E. Home has observed), the action of the two sets being in different directions, renders only one-half the quantity of contraction in each fibre necessary that would have been otherwise required; while the turn both sets make in opposite directions at the apex of the ventricle, fixes it, and prevents lateral motion.

The muscular fibres of the heart surround the origin of the pulmonary artery, but do not encircle the aorta.

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* The course of the muscular fibres of the human heart has been well represented by Mr William Cowper, in the 2d and 3d figures of his 42d Table, Lond. 1698; and also still more faithfully in five different figures in the 36th Plate of his Treatise on the Muscles of the Human Body, published 1724.

When we look from the ventricles into the mouths of the pulmonary artery and aorta, the former seems circular, the latter triangular.

The muscular fibres of the external stratum of the auricles, which are considerably thicker in the left than in the right auricle, describe segments of large circles, excepting where the auricles are, as it were, let into the ventricles: in these situations the fibres are circular.

Some of the muscular fibres of the auricles are evidently continuous with each other, but they are not so with those of the ventricles, for after boiling the heart for three or four hours, the auricles may be lifted up from the ventricles, without the laceration of any muscular fibres.

The auricles and ventricles are alternately contracted and dilated. After the ventricles have contracted, these cavities are dilated, and ready to receive the blood from the auricles. If the finger be applied to the heart of a living animal during its dilatation, it is evident that the muscular fibres are dilated with force.

The contractions and dilatations of the heart succeed each other quickly. According to KEILL each ventricle will contain an ounce of blood. The heart contracts 4000 times in an hour; from which it follows, that there pass through the heart every hour 4000 thousand ounces, or 350 pounds of blood.

BORELLI, KEIL, and HALES have endeavoured to estimate the force of the heart. The latter author made his experiments, by fixing a tube into the carotid arteries of living animals, and observing to what height the blood was projected from the tube; but all that can be ascertained by such experiments is, that the heart is a very powerful muscle. It is quite impossible to arrive at greater accuracy, until the resistance to which the attraction of the blood to the sides of the vessels,—the comparative quantity of blood in the arteries and veins,—the effect of the conical shape, anastomoses, and angles of the arteries,—the exact quantity of blood discharged at each contraction of the heart, and the effect of the sum of the area

of the branches, being greater than that of the parent trunk, have been ascertained.

The muscular fibres of the heart, like those of the other muscles, have occasionally been overstrained, and lose their contractile power to a certain degree, so that the pulse falls to between thirty and forty in a minute, which has been observed to happen when the coronary arteries have been ossified. The heart, also, has occasionally been attacked with spasm.

The nerves of the heart are very small in man. They have been annually demonstrated in the Anatomical Theatre of the University of this city for the last forty years, and have been described at great length, and also represented with great fidelity by Scarpa. They may be seen in the heart of a lean ox or horse, without any dissection. These nerves are derived from the eighth pair and sympathetic nerves.

There are arteries and veins proper to the muscular substance of the heart, which have been called *Coronary*. These take their rise immediately behind the semilunar valves of the aorta.

The corresponding veins unite, and form the large coronary veins, which open into the anterior auricle. It has been affirmed that, upon the internal surfaces of the auricles and of the ventricles, there are the open orifices of small arteries.

Thibesius wrote expressly on this subject, and hence these apertures have been called *The Foramina Thibesii*. I have seen a very penetrating liquor thrown with force into the coronary arteries, notwithstanding which, none of it passed into the ventricles of the heart, which leads me to doubt of the existence of such orifices.

The lymphatic vessels of the heart are numerous, and may be filled with quicksilver. The heart is a very irritable muscle, and preserves that power longer than the greater number of muscles of the body.

The muscular fibres of the heart have a most remarkable degree of sympathy with the other parts of the body.

Dr Wilson Philip's experiments have thrown much light

upon the laws which regulate the vital functions. That distinguished physiologist has shewn *, 1*st*, That the power of the heart and bloodvessels is independent of the brain and spinal chord; and, consequently, he has refuted the opinion of Mr Le Gallois, that the heart derives power from the spinal chord. 2*d*, He has also explained the relation which exists between the nervous and circulating systems, pointing out, that both the heart and bloodvessels may be influenced through the nervous systems, though they be independent of it, thus explaining why they are supplied with nerves; and, consequently, doing away the objection that has always been urged against the opinion of Haller, that, according to his view of the subject, the nerves of the heart appear to be useless,—an objection to which he never gave a satisfactory reply†, and which appears to be the only cause which prevented his opinion of the independence of the power of the heart being universally received. 3*d*, That the heart and bloodvessels are influenced by every part of the brain and spinal chord, while the muscles of voluntary motion are only influenced by the parts in the immediate vicinity of the origin of their nerves ‡.

The last general circumstance relating to the heart is, that its muscular parietes admit of considerable dilatation, which is either general or only partial. By some of the organic diseases of the heart, the size of the cavities is not only increased, but also the thickness of their muscular parietes; but, in others, the muscular substance is increased, but not the size of its cavities; so that it shall weigh two or three pounds.

An enlargement of the heart generally gives rise to an effusion of water within the sacs of the pleuræ, or within the pericardium, and is often accompanied or followed by chronic inflammation of the heart.

The partial enlargement of the heart is often the effect of a mechanical obstruction to the circulation of the blood, as from ossification of its valves, or of those of the aorta.

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* Chapter I. of his Enquiry into the Vital Functions, 2d edit.

† Vide Chap. II. of his Enquiry.

‡ Vide Chap. IV. of his Enquiry.

It merits also particular notice, that the heart (from a cause not easy to explain), sometimes attains a monstrous size, though there be no obvious impediment to the current of the blood. I have a specimen, in which the heart weighed nearly two pounds.

According to Morgagni, (Vide 18th Letter, 2d Art.), the heart sometimes has attained a large size, while the aorta has been rather smaller than usual. The patient's pulse was languid, frequent, and unequal; he had difficult breathing, and tendency to syncope*.

The partial enlargement of the heart is much more frequent than a general dilatation; and, in some cases, one side of the heart has been dilated, and the muscular parietes of the opposite side have been much thickened.

The human heart is double, or consists of two distinct hearts, one of which propels the blood through the lungs; the other, the stronger heart, propels the blood through the system at large: hence the one has been called the Pulmonic, the other the Systematic heart.

The greater share of the internal surfaces of each of the cavities of the heart is unequal. There are certain muscles placed within these, called the *Columnæ carneæ.*

The columnæ carneæ of the auricular portions of the heart are much smaller than those of the ventricles, and are disposed somewhat like the teeth of a comb.

The columnæ carneæ of the ventricles are rounded, of different lengths, and take their rise from the walls of the ventricles; and some of these terminate in small tendinous chords, which are fixed into the valves between the auricles and ventricles; others to the sides of the ventricles. These columnæ carneæ follow different directions, and interlace each other, so as, in some respects, to resemble a net-work.

In the posterior ventricle, the columnæ carneæ are of a more unequal size than in the anterior. Two of these columnæ carneæ of the posterior ventricle are larger than the others, and are fixed by small rounded tendons into the mitral valve. The columnæ carneæ render the walls of the

* Vid. also Mr A. Burns on the Diseases of the Heart.—Edin. 1809.

heart stronger, and also assist in incorporating the parts of the blood more intimately, and in preventing its coagulation.

The cavities of the heart, and also its valves, are lined by a very thin, but dense membrane, which prevents the blood from insinuating itself between the muscular fibres of the heart.

On each side of the heart, there are veins, an auricle, and a ventricle, communicating by large rounded apertures, and an artery. The corresponding cavities of the opposite sides of the heart are different as to the thickness of their parietes, and the colour of the included blood. The parietes of the anterior, or pulmonic heart, are thinner than those of the posterior or systematic heart, and the pulmonic heart is filled by blood of a dark purple colour, but the systematic heart contains blood of a brilliant red colour.

Of the Anterior Auricle.

The anterior auricle is situated on the right, and towards the basis of the heart. Upon laying the auricle fully open, the projecting anterior flattened and notched part, which lies in front of the aorta, and bears but a distant resemblance to the ear of a dog, is found to resemble the internal surface of the ventricle; and the columnæ carneæ being disposed somewhat like the teeth of a comb, have been hence named *Musculi Pectinati* of the Auricle.

The greater share of the auricle is smooth, and has been named the *Sinus*, which seems to be formed by, and to be the continuation of the large veins through which the blood flows into the auricle, called *Venæ cavæ*.

The muscular parietes of the auricles are so thin as to be semitransparent; and, on stretching the auricles, it is evident that, in some places, there is no muscular substance between the muscular fasciculi; for the outer and the internal membranes of the heart come into contact with each other.

The muscular flesh of the auricle is much thinner than that of the ventricle, as the auricle, by its contraction, merely propels the blood into the ventricle.

In the quadruped, there is a distinct projection of that part of the auricle, which intervenes between the entrance of the

vena cava superior, and vena cava inferior: This has been named by LOWER, *Tuberculum*; and the same name has been transferred to the corresponding portion of the human auricle: and, under this, an oval-shaped depression has been described; but it is rather of a circular form; and this is bound by prominent muscular substance.

There is sometimes a small aperture in the upper part of this depression, even in the adult; though generally there is no such aperture. This depression or fossa is bounded by a portion of muscle, which, at its upper part, has thick edges, and which has been described by VIEUSSENS, under the name of *Isthmus*.

The coronary vein is placed between the mouth of the vena cava inferior, and passage into the ventricle; and, over the termination of the vein, there is a valve like a crescent. There is an imperfect valve between the vena cava inferior, and the auricle, which is placed on the left side of the mouth of the vena cava inferior, and which covers one-half of the mouth of that vein. The membrane of the valve of the adult is generally perforated, and its convex edge is fixed to the union of the vena cava and auricle.

This imperfect valve, which is often cribriform, and commonly called the Valve of EUSTACHIUS, has a concave loose edge, looking obliquely upwards, and extending half way over the mouth of the vena cava inferior: this convex edge is fixed to that vein, and to the sinus of the right auricle.

The size of the valve differs in different individuals; and in the fœtus, it is proportionally broader than in the adult.

To give the current of the blood a particular course, more perfect valves are interposed between the auricles and ventricles, and at the mouths of the pulmonary artery and aorta.

The valves are formed in part by the internal membrane of the heart and arteries, and with the addition of a certain proportion of tendinous substance.

The valves between the auricles and ventricles, are composed of white, tough, and pliable membranes, from which several small tendinous cords proceed and descend, to be fixed to the columnæ carneæ of the ventricles.

The valve between the anterior auricle and ventricle, consists of three principal parts, and is somewhat of a triangular form; with its basis fixed to the columnæ carneæ of the ventricle: hence it has been called *Tricuspid Valve.*

This valve lies close upon the side of the ventricle; and, consequently, allows the stream of blood to flow into that cavity from the auricle. When the ventricle contracts itself, the columnæ carneæ are at the same instant contracted, and pull the loose edge of the membrane from the sides of the parietes, the blood insinuating itself under the valve; the projecting points of the membrane meet, and thus the communication between the auricle and ventricle is cut off.

If the extremities of that valve had not been connected with the columnæ carneæ of the ventricle, the valve must have been turned inside out, and thrown back into the ventricle; and hence the blood must have been refluent, and would have passed into the auricle, instead of flowing into the pulmonary artery.

The ventricles constitute the most essential part of the heart; they may be compared to a forcing machine, and therefore merit the most particular mention; the other cavities, called Auricles, being merely reservoirs, in which the blood is collected, during the contraction of the ventricle.

Of the Anterior or Pulmonary Ventricle.

The anterior ventricle is somewhat triangular in form, with the smaller extremity directed downwards, and convex in front and flat behind. Winslow, Senac, and Haller, entertained different opinions respecting the comparative size of the ventricles; as far as I can judge, the anterior ventricle has been represented as being larger in respect to the posterior ventricle than it is in nature; and this error as to the capacity of the ventricles, has originated in the greater thinness of the parietes of the anterior ventricle, which yield more readily to water, or any other fluid thrown into it, than the thicker parietes of the posterior ventricle.

The greater part of the inner surface of the heart is very irregular, owing to the columnæ carneæ and foveæ between

them, excepting at that place from which the pulmonary artery takes its rise.

Of the Pulmonary Artery.

This large artery takes its rise from the anterior ventricle, and its origin is marked by a white callous ring: it passes upwards behind the breast-bone, and divides into two great branches, through which the blood flows into the right and left lungs.

To prevent the stream of blood from flowing backwards into the ventricle, the internal coat of the artery is reflected, and forms three valves, somewhat of a semilunar figure, which are convex towards the ventricle, and concave towards the artery. Two of these are placed on the fore part of the artery, and the other on its posterior part; and each of these valves is directed upwards, so as to form a small sac, one edge of which adheres to about one-third of the circumference of the inside of the artery; the other hangs loose, within the cavity of the artery.

These valves yield before the stream of blood which flows from the ventricle; but when it is refluent, they are raised; and, with the aid of a small hard and red-coloured body, called the *Corpusculum Arantii*, which is in the middle of the loose edge of the valve, completely obstruct the artery.

The pulmonary artery opposite to the valves is somewhat enlarged, forming what anatomists have named *Sinuses*, of which there are three.

The opposite sides of the heart are separated from each other by a septum, in which the muscular fibres of both ventricles are intermixed; and, upon this septum, there are a number of columnæ carneæ.

Of the Posterior, or Systematic Heart.

The blood which enters the lungs by the pulmonary artery, flows by the medium of the four pulmonary veins into the posterior side of the heart.

The posterior heart is very similar to the anterior in its structure.

There are four veins from the lungs, which communicate with the left auricle, which is rather smaller than the right; and these four pulmonary veins open into the upper and back part of the auricle.

This posterior ventricle is shorter, and more rounded than the anterior ventricle, and somewhat of the shape of an ellipse. Within this ventricle, there are a number of columnæ carneæ, which are nearly similar as to course, with those of the anterior ventricle, but somewhat smaller than those of the anterior ventricle.

The mitral valve is fixed to the ventricle of this side of the heart, and it is considerably smaller than that of the right side; and every part of this valve is also firmer than that of the right side.

The auricular part of the posterior auricle is longer, but not so broad as that of the anterior auricle.

The flesh of this auricle is rather thicker than that of the anterior auricle, but by no means so thick as that of the ventricles. The opening between this auricle and the posterior ventricle is oval, but not so large as that on the anterior side of the heart; and from the circumference of this aperture, there is a white dense and tendinous-like line, from which the fibres of the valve between the auricle and ventricle take their rise.

The valve between the auricle and ventricle is nearly similar to that of the anterior side of the heart, but is composed of two principal parts only; and has, in shape, been compared to a Bishop's mitre, and has hence been called Valvula Mitralis. This valve is thicker than the tricuspid valve.

The muscular substance of the posterior ventricle, is much thicker than that of the anterior verticle, and the cavity of the ventricle is somewhat in form like an egg: but in the fœtus, the parietes of both ventricles are nearly of an equal thickness, as the anterior ventricle of the fœtus propels the blood through the canalis arteriosus, or through the system at large; and hence greater strength is required than in after life.

The ventricles of the heart do not communicate directly

with each other, but are separated by a partition, which is thicker towards the basis than at the apex of the heart.

This muscular partition receives fibres, from both ventricles of the heart; but the greater number are derived from the posterior ventricle.

Of the Aorta.

From the posterior ventricle the large artery of the body issues, called Aorta; the connection of which with the ventricle, has been accurately described by Baron HALLER.

" Caro cordis in circuli perfecti formam terminatur, et fibræ transversæ cordis, partim inter valvulas arteriosas per lineæ longitudinem producuntur, et aliquanto plus, partim in partem arteriæ, quæ sinum valvulosum perfecit, pariter sursum pergunt, fere per sesquilineam, et accurate transversæ cum alba pariter membrana arteriæ connectuntur, cellulosæ brevis telæ ope, ut nulla cordis fibram arteriam continuetur *."

The orifice of the aorta is separated from the opening into the auricle by a portion of the mitral valve; so that when the parts of the mitral valve are pressed together, so as to oppose the reflux of the blood into the auricle, the passage from the ventricle into the aorta becomes wider.

Of Communications between the opposite Cavities of the Heart.

There is an aperture in the partition between the auricles of the heart of the fœtus, through which a considerable part of the blood passes from the anterior into the posterior auricle.

This passage of communication sometimes remains open for years, by which the usual quantity of blood does not circulate through the lungs, in consequence of which it is imperfectly *oxidated.*

This unusual structure is generally characterised by the purple colour and coldness of the skin, by fits of difficult breathing, by impaired digestion, and occasional syncope.

But there are some exceptions to the above observation. One of them fell under my own notice, and the following were the appearances on dissection.

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* HALLERI Element. Physiol. lib. iv.

The heart was considerably enlarged, and towards its apex there was a thin layer of coagulable lymph; and also over the anterior auricle. Upon opening both auricles, they were found to form *one sac, which measured in its transverse diameter six inches.* There was no vestige of a partition between the auricles, excepting at the lower part. *The passage of communication between the auricles was nearly circular, and about three inches in diameter.*

The sinus of the anterior auricle was rather thinner than usual; but the auricular portion was twice as thick as usual; and the musculi pectinati were very distinct. The inner membrane of the auricle had a pale crimson colour.

The Eustachian valve was larger than usual, and its cornua were proportionally elongated.

The coronary vein was considerably enlarged.

The passage of communication between the right auricle and right ventricle, was about two inches in diameter.

The membrane of the anterior and posterior portion of the tricuspid valve, was thickened irregularly, but not considerably. The anterior ventricle was larger than usual, by nearly a half; and the thickness of its parietes was equal to that of the parietes of the posterior ventricle in its sound state. The columnæ carneæ were also enlarged.

There was a considerable ossification of the valves at the mouth of the pulmonary artery, so that there was merely an aperture between them, about half an inch in diameter.

The sinus of the left auricle was thinner than common; the auricular portion had the usual form, but was considerably extended, and equally so in all its dimensions. About ten ounces of a yellow coloured fluid were found within the pericardium, with shreds of coagulable lymph passing through it.

It may be proper to add, that this person, before death, had an irregular and very feeble pulse, but *none of the other symptoms of imperfect oxidation of the blood*, owing, probably, to the simultaneous contraction of both of the auricles.

In some instances, the aorta has taken its rise from the right as well as from the left ventricle.

I have a specimen, in which the foramen ovale, and also

the passage between the pulmonary artery and aorta is open in the adult.

Morgagni has made mention of his having met with a communication between the ventricles of the heart.

In the three last instances, the blood was imperfectly oxidated.

SECTION IX.

GENERAL OBSERVATIONS ON THE ARTERIES.

The arteries are those tubes connected with the heart, by which the blood is distributed to different parts of the body. The arteries, during life, are distinguished (the pulmonary artery excepted), by the florid colour of the blood they contain; by their pulsatory motion; and by the course of the stream of blood.

After death, they are distinguished by their thick whitish coats, by having no valves, excepting at their origin from the heart; and, owing to the elasticity of their coats, presenting, when cut through, a circular orifice.

Of the Disposition of the Arteries.

By the arteries, which are elastic and muscular tubes, the blood flows to the different parts of the body; and by the veins it flows backwards: the heart is the machine which assists in propelling the blood, and which is placed where the arteries and veins meet, in order, by its action, to restore to the blood the momentum it had lost during the circulation.

The blood, in passing outwards, flows from wider into narrower tubes; and, in returning, from narrower into wider vessels.

The arterial system has been compared to a cone, of which the apex is at the heart; but an individual artery cannot be compared to a cone; the common carotid or vertebral arteries, for instance, are cylindrical tubes. The larger trunks of the arteries are included in a considerable quantity of cellular sub-

stance and fat, and are so situated as to be at the greatest possible distance from external injury.

The larger arteries are situated on the bending side of the body; thus the carotid artery and aorta are placed in front of the spine; the subclavian and humeral arteries on the inner side of the scapula and humerus; and the arteries of both extremities are placed on the bending sides of these: hence, instead of being contracted when the arm or leg is bent, they are rather enlarged, and the flow of blood through them is not impeded. The branches of the larger trunks of the arteries are generally nearer to the surface than the parent trunks.

Some of the arteries are placed between the processes, or within canals of the bones, as in the lower jaw, or in grooves in the ribs. They are placed on the bending sides of the joints, otherwise they would be overstretched.

The larger arteries are seated much deeper than the veins: the cutaneous branches of these are small and short; whereas many of the trunks of the veins are seated under the skin, and many of their smaller branches are deep seated. The larger branches of the arteries are pretty constant as to their situation; but the same observation is not applicable to the smaller branches; and, even in the corresponding limbs, there is much variety as to their origin, course, and mode of distribution.

The arteries divide into numerous branches, somewhat like a tree: these are sent off from their trunks at different angles; generally at an acute angle, as in the extremities, but sometimes at a right angle, as in the intercostal or renal arteries, or, like the superior intercostals, at an obtuse angle; and, at the place of the division, a projection may be observed on the inside of the artery, formed by the internal coat. If the angle at which the branch is sent off be a right angle, the edge is circular; but when the angle is acute, there is a sharp projection of a semicircular shape.

In general, the arteries take the shortest road: thus less force is required. There are, however, some exceptions to the above observation; as in the case of the arteries of the brain.

The larger trunks of the arteries are placed between the lobes of the parts on which they are distributed, and the branches enter into its substance, as in the case of the brain, glands, and muscles.

The smaller branches of the arteries are more exposed, and more convoluted in their course, than the larger branches, and more especially those distributed upon organs which undergo a rapid alteration as to their size, as those of the lips, stomach, and uterus; and, in other cases, this convoluted course is probably subservient to secretion. Thus the spermatic artery follows a long and tortuous course before it reaches the body of the testicle; and this more especially in quadrupeds.

It may perhaps be owing to this cause, that the artery, lodged within the under jaw, is seldom or never torn when that bone is broken.

If the above arteries did not follow a tortuous course, they must have been much extended, and contracted, when the womb or lips are much extended; whereas, by means of their tortuous course, they accommodate themselves to the exact condition of the parts they supply.

It is evident that the size of the branches of an artery, taken together, exceeds that of the parent trunk. It is difficult to determine the exact degree of enlargement, as it varies in the different organs. To me it seems probable, that, at an average, when an artery, as the aorta, divides into two branches, the proportion of the two branches, compared with the trunk, is as three to two. As these divisions are frequently repeated, the capacity of the arteries must be continually increasing as they proceed from the heart to the extremities; hence the arterial system has been compared to a cone, with its apex at the heart.

The arteries of the stomach, intestines, heart, joints of the extremities, &c. which are liable to sudden and unequal pressure or contortion, in their course, are frequently united, or form *anastomoses*. In some cases, two trunks equal in size are united; but in others, a small trunk is joined to the larger.

There are instances, in which two trunks meet in an arch, as in the mesenteric arteries, or two trunks meet at an acute

angle, or two trunks are united by a transverse branch, as in the anterior cerebral arteries; and in the case of the basilar artery of the brain, there is an example of two trunks uniting, to form a trunk larger than either of the vertebral arteries which form it.

The anastomoses are much more frequent in the smaller than in the larger ramifications of the arteries, and in the more minute arteries are so numerous, as to form a very intimate network.

The purpose of anastomosis is to prevent obstruction; so that, if the course of the blood shall be obstructed in one artery, it may continue to flow through a neighbouring anastomosing branch.

It is of great moment for students to be intimately acquainted with the anastomoses of the arteries around the joints. From the more intimate knowledge which surgeons have acquired of the anastomoses of the arteries, that part of the practice of surgery relative to the treatment of diseased arteries, has been of late much improved. About a century ago, when the iliac, or even femoral artery, or the subclavian arteries, were diseased, nothing was attempted for the relief of the patient; but now ligatures are thrown around these large and important arteries, and the disease is often cured; for thus the circution does not cease, but is continued by the medium of the lateral anastomosing branches of the arteries, which become very considerably enlarged, and follow somewhat of a tortuous course.

Sir A. Cooper has lately ascertained that, though a ligature be thrown around the lower part of the aorta, the blood still continues to flow to the inferior extremities.

Of Varieties as to the Size of the Arterial System.

The arteries of the body gradually increase with the bulk of the body; and when the size of a part varies, so does that of the artery proper to it.

These varieties are temporary or permanent. The gravid uterus affords an example of the former. As that organ increases in bulk, its arteries are much enlarged; but, after

delivery, the bulk of the organ, and also that of its arteries, is much diminished. In the same manner, the arteries in the vicinity of a tumour acquire an unnatural size; but upon the tumour being removed, they shrink; but if that tumour cannot be removed, the increase in the size of the vessels is permanent.

The arteries of the placenta are peculiar as to their course. They follow a long and tortuous course, and do not diminish in size until they divide into many branches upon the substance of the placenta.

Comparative Vascularity.

There are many more bloodvessels proper to the several organs of a young, than to those of an old animal. In old age, the heart loses its force, and many of the smaller bloodvessels are obliterated; the skin, having then less blood than in early life, becomes of a paler colour; it loses its former pliability, becoming hard and scaly; the muscles lose their former red colour and suppleness; and the coats of the arteries become more rigid, and are frequently converted into bone.

It is a general law, that, during the formation of a part, it is more amply supplied with bloodvessels than after it has been completely formed.

All parts which are active, are most liberally supplied with blood. Thus, the bones, tendons, ligaments, and other serous membranes, receive but a scanty supply of blood, while a large quantity of blood is sent to the muscles, glands, and organs of sense.

In some cases, blood is suddenly determined to a part, in order to increase its sensibility.

In old age, on the other hand, a great many of the arteries are obliterated.

Of the Terminations of the Arteries.

The arteries terminate in different ways.

Most of the branches of the arteries, whether conveying the red or the colourless part of the blood, terminate directly in veins.

Those arteries which are of so small a size, as to admit on-

ly the colourless part of the blood, have been called *Capillary.* These constitute a considerable part of the animal frame.

Many branches of the arteries terminate upon glands; others in exhaling arteries, which lubricate the surfaces of the serous membranes that line the cranium, the thorax, and abdomen; besides which, there are numerous excerning arteries upon the surface of the skin, and internal surface of the lungs.

Lastly, Some of the branches of the arteries terminate in the penis and clitoris, which have been by some authors supposed to be organs of a cellular structure.

In short, by the capillary system many of the most important functions of the body are performed, as nutrition, secretion, exhalation.

These capillary arteries probably possess even a greater degree of muscular power than the larger branches; they are more under the influence of passions of the mind: besides, the heart can have but little influence in propelling the blood through the smaller branches of the arteries; the circulation of the blood in them must, therefore, be more the result of their own inherent muscular power than of the action of the heart.

Of the Formation of New Arteries in cases of Wounds.

When a part of the body has been wounded, the original arteries are either elongated, or new arteries are formed, which pass across the wound, and meet with those of the opposite side.

SECTION X.

GENERAL OBSERVATIONS ON THE VEINS.

The veins which have no branches are somewhat of a cylindrical shape, but others are of a conical form.

The veins take their origin, according to some authors, from the cells of the placenta, corpora cavernosa, penis, and clitoris, from the sinuses in the brain, or from other veins, as in the liver, and from the arteries.

The small branches of the arteries may, by the microscope, be observed to be continuous with the veins, which fact may be made very obvious by a coloured injection.

There are veins which correspond with the arteries, which are filled by the coloured part of the blood; and others, which correspond with the arteries, which are so small, as to admit only the colourless part of the blood.

The capacity, and also the number of the veins, surpasses that of the arteries; according to HALLER, the inferior cava is to the aorta as 16 to 9. But there are some exceptions to this rule; thus, the renal, bronchial, and some other veins, are smaller than the corresponding arteries.

The proportional bulk of the veins differs at different periods of life. In early life the veins are small when compared with the arteries, but in old age, the veins are proportionally much larger.

It seems to me impossible to form an exact ratio between the size of the arteries and that of the corresponding veins during life, as the size of the veins varies according to the degree of their distention; and a calculation made after death is apt to lead to error, as, owing to the cause of death, the coats of the veins, which are very distensible, yield more or less, and are more or less distended by different diseases.

Thus, in cases of asphyxia, death from hanging, and apoplexy, blood is accumulated in the veins; but in other diseases they are nearly empty.

Much also depends upon the position of the dead-body: thus, as a dead body is generally laid on its back, that portion of the lungs which is undermost is always of a deeper colour than the upper portions of the same organ.

The ratio of the size of arteries and veins differs in different organs: thus the pulmonary, renal, and thymic, veins bear a smaller proportion to the arteries of the organs, than in other parts of the body.

The veins of different sizes unite, and the angles formed by their union are different; most frequently they are acute, but at other times obtuse.

The course of the veins is not similar to that of the ar-

teries, excepting within the cavities of the body. There are many of the larger trunks of the veins which lie under the skin; whereas the larger branches of the arteries are deep seated in several parts of the body, as in the organs of generation, &c., and under several parts of the skin, in which there are venous plexuses without corresponding arteries, as the vena azygos of the pia mater.

The larger branches of the veins, like those of the arteries, are lodged in the vicinity of the processes of the bones, between muscles, or the lobes of glands, from which they receive protection.

The veins are less tortuous than the arteries.

The branches of the veins communicate with each other more freely and more frequently than the branches of the arteries; they communicate by a straight canal, or by arches; or the communications are so numerous as to form a plexus.

The communications between the branches of the smaller veins are most numerous where the course of the blood in these is more apt to be interrupted by violent motion, by the effect of gravitation during our erect posture, or by external and internal pressure: hence, the spermatic veins freely and repeatedly communicate with each other.

The above free communication is very necessary in the venous system, as the return of the blood is more apt to be obstructed by the effect of gravitation, posture, &c., and by tumours, than in the arteries.

Valves are found in the larger veins, particularly, those which are placed perpendicularly, as in the limbs; and where the pressure occasioned by the contraction of the superincumbent muscles might have rendered the blood refluent.

The only internal veins which have valves are the vena azygos and spermatic veins.

The valves are formed by a reflexion of the innermost coat of the vein; each valve has a fixed and loose edge, which latter floats loose within the vein; the valves are of the figure of a parabola; are concave towards the heart, and are generally disposed in pairs; and these valves are perfectly similar to

each other. These valves are remarkably tough; and are more numerous in some than in other veins.

Single valves are sometimes found in the veins of the hands and feet.

A pair of valves has been described in the external jugular veins, and valves have been observed in the branches of the internal jugular veins.

The veins are somewhat expanded into a sinus opposite to the valves, which gives the vein a knotted appearance.

The valves prevent the regurgitation of the blood; they clap close to the sides of the veins during its flow towards the heart, but are raised when the blood is refluent.

On account of the position of the veins, and greater size and thinness of their coats, the pressure of the neighbouring organs and gravitation, must have a greater influence upon the blood through them than within the arteries.

The return of the blood to the heart through the veins is promoted by the muscular contraction of their coats, by the contraction of the neighbouring muscles, by the pulsation of neighbouring arteries, and by the valves, which prevent a retrograde motion.

The velocity of the blood in the smaller veins is probably equal to that of the blood within the smaller ramifications of the arteries, and the blood continues to flow more and more rapidly within the larger veins, near to the heart, the area of the venæ cavæ being much less than that of the branches of the veins which discharge their contents into it.

The veins yield more readily, and are much more dilatable, in the transverse direction than the arteries, but they can be extended but little in the longitudinal direction.

There are vasa vasorum proper to the coats of the veins, as well as to those of the arteries.

In short, the veins may be distinguished from the arteries by the greater thinness of their coats,—by their greater number and size,—by their want of pulsation,—and by the blood within them flowing in an uniform and uninterrupted stream, —by the dark purple colour of the included blood,—and by the number of the valves.

Those veins which lie over the arteries seem to pulsate, but this seeming pulsation is derived from the subjacent artery; for it ceases as soon as the vein is drawn aside from the artery.

In some of the organic diseases of the heart, the large veins, in the vicinity of that organ, acquire a pulsation, which is owing to the contraction of the auricle preventing, for a moment, the free entrance of the blood.

The arteries being more immediately exposed to the impulse of the blood, which is projected with considerable force by that powerful muscle the heart, have thicker and stronger coats than the veins.

The thickness of the coats of the arteries is not uniform; it bears a ratio to the situation of the artery: thus the coats of the pulmonary artery are thinner than those of the aorta. The smaller arteries, in proportion to their size, are stronger than the larger trunks, as has been ascertained by fixing weights to them.

Sir C. WINTRINGHAM tried many experiments on the strength of the coats of the arteries, by injecting air into them, and found it to be very considerable; he says, the aorta, of a young subject, near the heart, was burst, by a force equal to 119 lb. 5 oz., the splenic artery by 41 lb. 8 oz., and that the strength of the renal artery to the aorta was as 51 to 40.

There is a certain balance between the muscular power of the heart and the resistance of the arteries, which, when destroyed, leads to disease, as it occasions a deranged state of action of the sanguiferous system. When the parietes of the heart have attained an unnatural size, the pulse becomes intermitting and irregular, and sometimes slow; and the heart may be felt contracting slowly.

The functions of the lungs are also impaired, not only by increased bulk of the heart, but also on account of the effusion of water within the chest; the usual concomitant of morbid enlargement of the heart.

The arteries possess a considerable share of elasticity, and their sides do not collapse, even when empty: hence an artery, when divided, presents a circular orifice.

In consequence of this elasticity of the arteries, they yield, when the blood flows into them by the contraction of the heart; and by the same means the artery regains its former situation.

When an artery pulsates, it undergoes a change of place; and it regains its original situation, on account of its elasticity.

Owing to the elasticity of the arteries, when an injection is thrown with great force into them, they are elongated, and becomes tortuous in their course.

Owing to the same cause, the arteries preserve their caliber, to a certain extent, though they contain no blood; for if two animals, of equal size, be killed, and if one of them be bled to death, the arteries of the one killed in the latter way, are diminished to one-half of their bulk, the muscular contractile power of the arteries having overcome, to a certain extent, their elastic power.

The arteries also possess a contractile muscular power.

The subjoined is an extract from a paper of my Father, dated August 1. 1761, entitled by the author, "Observations and Experiments made on Frogs, concerning the circulation of the blood,—the influence of the heart, and of the small arteries, in promoting the circulation of the blood,—and on the nature of inflammation."

"*Experiment* 1.—The ventricle of the heart, brought into view by cutting away the sternum, contracts fifty-eight times in a minute, with great uniformity, both in the degree of its repletion, and times between the contractions.

"*Experiment* 2.—In the smallest visible arteries of the membrane between the toes, the motion of the blood, seen with the microscope, appears so uniform, whilst the animal is vigorous, that it is impossible, from observing that, to have any idea of the number of contractions the heart performs in a given time.

"*Experiment* 3.—But, in moribund animals, where the contractions of the heart were less frequent, and performed with less force, I could distinctly reckon the number of strokes of the heart, by looking at the smallest visible arteries, in which

the blood only moved forward when the heart contracted; nay, I could, in like manner, number the strokes of the heart, by looking at veins composed of at least a dozen capillary branches, a similar subsultory motion being equally well perceivable in them.

"*Experiment* 4.—I cut the crural nerve, of one side, at the top of the thigh, and drew the divided ends asunder, so as to make it impossible for them to reunite. The animal was instantly rendered insensible of injury done to the foot; yet the circulation was as rapid between the toes of that foot as between those of the other foot, and continued so for fifteen weeks, though the animal was still insensible of the most violent injury done to the toes. On dissection, the ends of the nerves were not reunited, but had grown, by a cellular substance, to the neighbouring muscles. The end of the nerve next to the spinal marrow, was enlarged, the other end was diminished; and the whole nerve, from that to the foot, was rather of a less bright colour than natural. That leg was, however, smaller than in the other considerably, their circumference being, to each other, as 37 is to 44; and hence the solid contents were, to each other, nearly as 13 is to 19.

"*Experiment* 5.—I applied pure spiritus cornu cervi to the foot of a frog, and which seemed to be much hurt by it; and, in a few minutes, the scarf skin was separated from the skin, and the whole foot was very red.

All the small arteries were redder and larger, and their communications with the veins much more visible than they are naturally.

The number of the small arteries did not seem to be increased, or I could not observe an *error loci* of the globules; but in the interstices of the vessels there was more than common yellowness, as if there had been an exudation into the cellular membrane of some part of the serum, perhaps mixed with some of the red part of the blood.

"*Experiment* 6.—On applying spiritus cornu cervi to the tail of a water salamander, the appearances were exactly the same as have been described in the last experiment.

" *Experiment* 7.—After boring the point of the tail of a water salamander, and the web between the toes of a frog, I examined the consequent inflammation for four or five days with the microscope. The redness seemed almost entirely owing to an extravasation of a bloody water, in which no globules could be observed, through which vessels carrying red globules passed, the communications of which with the veins were redder and more distinct than in other places, as these vessels were somewhat enlarged.

" *Experiment* 8.—The appearances were entirely the same three days after the medulla spinalis was destroyed from the middle of the back, or after all the crural nerves were cut.

" *Experiment* 9.—After the eschars made by the hot iron had separated, I placed the inflamed end of the tail of the water salamander before the microscope, of which the appearances are described in Experiment 5. I then touched it with spiritus cornu cervi. The vessels in the inflamed part very soon became more distinct, or they were more distended with blood and larger; and then the blood was poured forth from the mouths of a number of vessels upon the end of the tail, or from any part of the edges from which an eschar had separated.

" *Experiment* 10.—I cut one of the crural nerves at the top of the thigh, and then bored holes with a cold, and burnt them with a red hot, wire, in the web between the toes of both legs. The subsequent inflammation around the edge of the holes was similar in both legs, both to the naked eye, and with the microscope.

" *Experiment* 11.—I cut one of the crural nerves of the top of the thigh, and then broke both legs, and found, that the subsequent swelling, redness and callus, which reunited the bones, agreed as to every visible mark. But the animal did not appear to feel when the calves of the leg, whose nerve was cut, was bent, pinched, or pricked.

Seven days after destroying the posterior end of the spinal marrow I broke both legs, and upon examining them three weeks thereafter, found they were joined by a bulky callus,

which did not give the animal pain when it was pinched, cut, or touched with spirit of hartshorn."

Hence inflammation, new vessels, and new parts, may be added to the body, where there is no perceivable motion nor sensation of a member, as soon and as perfectly as where the nerves are entire; and, therefore, the formation of these does not depend so much on nervous influence as many, with great appearance of reason, have imagined.

My Father, in the observations he has appended to his description of a male monster *, has made mention of his experiments and observations, which demonstrate this contractile power of the arteries and veins.

In the monster he has described, there was no heart, but all the other apparatus of circulation; the blood, therefore, must have been carried through the arteries and veins, by a muscular power which is inherent in the parietes of these vessels. The experiments of Drs Verschuir, Wilson Philip, Hastings, and of Mr J. Hunter, to which I refer the reader, afford additional evidence of the same truth. I shall therefore only state, that the arteries of persons killed by hanging, are found empty, and, like the other muscles, in a state of rigid contraction, which they retain for ten or twelve hours,—that the arteries of an animal, bled to death, are found quite empty; and also, that, according to Mr J. Hunter, the arteries, like the heart in the class of amphibia, may be excited to contraction, for several hours, after they have been separated from the body.

The coats of the arteries admit of considerable extension; they are often extended into those tumours called *Aneurisms*. Such tumours are of two different kinds; the first is formed by the uniform expansion of all the coats; the second kind is formed by the internal coats giving way, and by the expansion of the outermost cellular coat of the artery into a sac †; which latter, according to the observations of Sennertus and Scarpa, is the most frequent kind of aneurism; but, accord-

* Phil. Trans. Edin. vol. iii. † Vide Plates II. and III.

ing to the preparations in the museum of the University, the more rare kind of aneurism.

The coats of the veins are thinner, more flexible, and yield more readily than those of the arteries, from slight causes.

There is considerable difference in the thickness of the coats of different veins. As far as I have observed, the muscular fibres of the vena cava, and vena portarum, are thicker than those of the other veins. Though the coats of the veins be thinner than those of the arteries, they are, according to Sir Clifton Wintringham, proportionally stronger.

The gravity of the blood has a considerable effect on the size of the veins. To counteract the effect of the gravity of the blood, the coats of the veins of the inferior extremities are thicker than those of the superior, notwithstanding which, the veins of the legs are often much swollen in persons who remain long in an erect position.

The above circumstances are worthy of particular notice, in the treatment of enlargement of the veins of the inferior extremities, and point out the advantage of the horizontal position, and of the application of a laced stocking over the enlarged veins.

The coats of the arteries and veins are less liable to give way, in consequence of ulceration, than the muscles. In malignant ulcers, we often observe the muscular substance consumed, but the coats of the bloodvessels continue sound.

The parietes of the arteries and veins may be divided into a greater or smaller number of layers. Some authors have divided the walls of the arteries into seven distinct layers; but anatomists, of the present day, adopting the division of my Grandfather, describe *three layers only, as being proper to the arteries and veins:* and between these coats there is no fat.

The arteries within the thorax and abdomen have an additional coat, from the pleura and peritonæum. There are small vessels proper to the coats of the arteries, called their *Vasa Vasorum*, by the medium of which they receive their nourishment; hence, when that supply of blood is cut off, by the use of several ligatures, or by the use of a very broad liga-

ture, or by a piece of cork interposed between the ligature, that part of the artery around which the ligature is thrown, must die.

These vasa vasorum do not come directly from the trunk of the artery itself, but from the neighbouring arteries. The trunks of these arteries wind through the cellular substance, around the external coat of the artery, and their smaller branches seem to be spent upon that coat; for I never have been able to trace these vessels upon the internal serous coat of the artery, even after a very successful injection.

The small veins or venæ venarum accompany the arteries in their course; and it may be observed, that the vasa vasorum are not enlarged in the case of aneurism, as the bloodvessels are in the vicinity of tumours of the mamma, testis, &c.

There are many lymphatic vessels which are proper to the coats of the arteries, otherwise their cavities could not be extended, in proportion to the bulk of the artery.

There is every reason to suppose, that the coats of the arteries are provided with absorbent vessels.

In many parts of the body the absorbent vessels run along the coats of the arteries and veins, but I have not seen absorbent vessels passing through the coats of the arteries or veins.

The absorption of the blood, in cases of aneurism, proves, that absorbent vessels are proper to the coats of the arteries. When an aneurism is spontaneously cured, the layers of coagulated blood are absorbed, and the opposite sides of the artery adhere to each other; so that, instead of perceiving a large tumour, filled by coagulated blood, we find merely a cord, which is, to the touch, like to a fiddle-string, and is not larger than it.

The arteries also preserve their relative size to the body, which is alone a sufficient proof that absorbent vessels are proper to the coats of the bloodvessels.

Nerves are also proper to the coats of the arteries and veins; these creep along the coats of several of these vessels, as along the coats of the bloodvessels of the neck, thorax and abdomen.

There are other circumstances which afford strong evidence of the arteries being supplied with nerves.

When the action of the arteries is increased, the nerves are also affected; thus, by passions of the mind, palpitation is induced.

Voluptuous ideas determine the blood to the penis, and produce erection: Anger impels the blood into the smaller arteries, and produces redness of the face.

Excessive grief or joy promotes the flow of tears, and impels the blood into the finer vessels of the skin.

An unusual flow of blood to a part increases its sensibility; as in an inflamed eye, or when the penis or clitoris are erected.

Inflammation renders the sense of touch more acute.

Grief impedes digestion, and diminishes the secretion of the gastric juice: On the other hand, a loaded stomach blunts sensibility, and produces sleep.

Fear also augments the secretion of the mucus of the intestines, and causes diarrhœa.

The influence of the nerves upon the arteries is evident. By throwing a ligature upon a nerve, the quantity of the fluid secreted by the gland is diminished.

Nuck found, that the division of the nerves leading to the salivary glands diminished the usual quantity of saliva.

An experiment which my Father performed, and of which an account is published in the Edinburgh Philosophical and Literary Essays, adds an additional illustration of the sympathy which exists betwixt the arteries and nerves.

He found, that, upon pouring a solution of opium under the skin of the thigh and leg of a living frog, not only the leg itself was very soon affected, but also the most distant organs of the body, by a sympathy of the nerves; but when he cut out the heart, or tied up or cut across the bloodvessels of the thigh, the distant parts of the body *were not affected;* hence the cutting out the heart, and throwing ligatures upon the arteries, prevented the nerves from propagating their influence by sympathy; and this also proves the sympathy between the arterial and nervous systems.

Lastly, The nervous action is not only influenced by the quantity, but also by the quality of the blood.

The application of a ligature to an artery sometimes creates pain, especially in the case of the spermatic artery.

An aneurism of the descending aorta creates very excruciating pain, owing, I should suppose, to the pressure and extension of the nervous plexus which envelopes that artery.

The arteries are connected to the neighbouring parts by cellular substance; thus they can be readily adapted to the varied movement of the limbs, and readily change their place when they are enlarged, and when the pulse is felt.

The arteries and veins are provided with an external cellular coat, composed of very fine threads, and which internally is condensed into a dense white layer.

In this external coat the elasticity of the arteries chiefly resides.

The second or muscular coat of the arteries, or the middle coat of some authors, is evidently composed of reddish-yellow fibres, which describe segments of circles.

The colour of the fibres of this coat varies in different arteries, being most evident in the arteries of middle size, as in the humeral and femoral and popliteal arteries.

This coat has a considerable degree of firmness, notwithstanding which, it is cut through by the application of a narrow ligature, whilst the external coat remains entire, as Dr Jones has proved.

Dr Jones supposed the division of the muscular and internal coats to be essential to the effusion of coagulable lymph, and to the process of adhesive inflammation, by which the vessel was closed.

But Dr Jones was mistaken on this point; for pressure is sufficient to produce the adhesion of the opposite sides of an artery, and the obliteration of its canal. I have a specimen in which this took place most completely in the humeral artery; besides, the records of Surgery contain many instances of aneurisms being cured by compression; and within these few weeks I saw a popliteal aneurism cured by the application of pressure. Some authors have described longitudinal fibres as

well as circular fibres in the veins, but the former I have not seen.

Harvey and Glisson supposed that the veins possessed a sort of peristaltic motion. Verschuir, my Father, and Dr Hastings, have proved clearly by their experiments, that the veins are irritable, and contract upon the application of a stimulus.

The innermost coat of the arteries is very thin and transparent, is remarkably smooth, and besmeared by a fluid which is very like to the synovia of the joints.

It is evidently the continuation of the same serous membrane that lines the cavities of the heart.

This membrane is joined to the muscular coat by fine cellular threads, and, when taken from an animal recently dead, has a yellowish-red colour: when allowed to remain in water, it often assumes more of a red tint, and when there had been no reason to suppose it had been inflamed.

In some diseases this coat assumes a brilliant red colour: this I noticed nearly twenty years ago in the body of a woman who died of diabetes, and I have since that period repeatedly noticed the same appearance in different disorders. *

A partial ossification of this internal membrane is more frequent than in any other part of the body. In all bodies of persons far advanced in life, that I have examined, I have found it to a greater or less degree, and especially in the arteries of the inferior extremities.

There are certain parts of this membrane in which bone is more readily deposited than in others, and especially in that part of it which is proper to the mitral valve of the heart and semilunar valves of the aorta. I have seen it very rarely in the tricuspid valve and semilunar valves at the origin of the pulmonary artery, or in the coats of the veins.

This ossification is not preceded by the deposition of cartilage: it takes place upon the outer side of this coat: the ossified portions are seldom thicker than the nail, have ragged edges, and are composed of very thin layers of bone.

* Vide Dr Duncan's Annals of Medicine, vol. viii. p. 388.

Those pieces of bone connected with the inner membrane of the artery, sometimes attain the thickness of a half-crown piece, and encroach upon the cavity of the artery.

The valves of the veins are formed by duplications of the internal coat, which project into the cavity of the veins; and, according to Mr HUNTER, there is a certain proportion of a tendinous substance which enters into the structure of the valves. The valves appear to differ in some after death, which seems to depend upon the degree of distention of the veins.

The internal coat of the veins, though thinner than that of the arteries, is not so easily torn, and is more distensible; and it may also be observed, that the inner membrane of the veins is very rarely ossified.

Lastly, it may be observed, that there is no reason for supposing that the absorbent vessels take their origin immediately from the arteries or from the veins.

SECTION VIII.

INFERENCES RESPECTING THE NATURE OF THE BLOOD AND ITS CIRCULATION.

FROM what has been stated respecting the nature of the blood, and the structure of the heart, arteries and veins, the following inferences may be drawn:

1*st*, That the blood is the source from which every part of the body was formed, and is nourished, to supply the waste that is constantly going on in the animal frame, during the performance of its several functions.

2*d*, That the coagulation of the blood may have a great effect in stopping bleeding. This I have seen exemplified in a very striking manner in many instances, and more especially in one I saw with Mr ALLAN and the late Mr J. BELL, in which a miller's arm was torn off by a wheel. Though the axillary artery and vein, which are so near to the heart, and of so large a size, had been torn, two or three ounces of blood only were lost. Several of this man's ribs had been broken,

and he died in three days from an inflammation of the lungs. Upon dissection the orifice of the artery was found completely obstructed by coagulable lymph, and also that of the corresponding vein, and the nerves composing the axillary plexus were considerably enlarged. The contortion to which these vessels in the arm must have been exposed, together with their elongation, may have had considerable effect in preventing the flood of blood; for we see that animals by instinct nibble the navel-string, twist it in different ways, and draw it outwards, and no bleeding follows.

3d, That, notwithstanding the great light which modern chemistry has thrown upon the chemical nature of the animal fluids, yet we have not yet arrived at a perfect knowledge of the blood, which, by the experiments of my pupil Dr Blundell *, and those of MM. Prevost and Dumas †, has been found to be different in different animals. These gentlemen have found that the blood of an animal of the same species may with safety be transfused into another animal of the same species; but that the transfusion of the blood of an animal of a different species generally proves fatal. Though the blood be altered by disease, there are no well authenticated facts which prove a well marked difference in its chemical composition.

The experiments of Fourcroy have pointed out the differences between the blood of a child and of the adult. There is no fibrin in the former, but instead of it a gelatinous substance, which does not become red by the contact of the air.

4th, The blood, during its passage through the lungs, is changed from venous to arterial blood. The former is of a purple colour, but the latter is of a brilliant scarlet hue. According to the latest experiments of Dr J. Davy, the temperature of arterial blood is higher by a degree and a half; and, according to Dr Crawford, it has a greater capacity for heat.

From the preceding account of the structure of the heart,

* Med. Chir. Trans. Lond. vol. ix. † Biblioth. Univers. tom. xvii. p. 342.

arteries and veins, I shall add, in the form of induction, a few general observations respecting the circulation of the blood.

1*st*, The blood which flows from the left ventricle is distributed by the arteries to almost every part of the body, (excepting to the cuticle, hair, and enamel of the teeth), and returns to the heart by means of the veins, which end in the right auricle. The use of the heart is to assist in propelling the blood through the arteries, and to receive it from the veins, the former of which are filled by blood of a brilliant scarlet colour, and the latter by blood of a dark purple colour.

2*d*, It is obvious that the structure of the heart has a reference to the lungs; it is a double organ: There are two hearts, one proper to the lungs, another proper to the rest of the body; or there is a particular circulation through the lungs, and a general circulation through the rest of the body.

3*d*, The heart, arteries and veins, are hollow muscles, and by contracting expel the included blood; and they are muscles of considerable strength, as has been proved by Sir Clifton Wintringham.

4*th*, The heart is an organ of involuntary motion; its action being not at all dependent on the will; neither does it depend upon the brain or nerves: For the heart continues to contract immediately after the head has been removed *, and

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* My Father long ago remarked, in his book upon the Nervous System, that the heart of a frog continues to act for some time when cut out of the body; and also that a frog continues to live, and even to move its limbs for two days after it has been decapitated.

Mr Cruickshanks (1) observed, that if an animal was pithed, by dividing the spinal marrow in the upper part of the neck, respiration ceased; but the heart continued to act, circulating dark coloured blood; and from ten to fifteen minutes elapsed before the circulation ceased.

Mr Bichat (2) and Mr Brodie (3) have also remarked, that the brain is not directly necessary to the action of the heart, and that when the functions of the brain are destroyed, the circulation ceases only in consequence of the suspension of respiration; and the latter gentleman also found, that if respiration was produced artificially, the heart continued to act for a still longer period after the removal of the brain.

(1) London Phil. Trans. for 1795.

(2) *Vid.* his Book Sur la Vie et sur la Mort; also his Anat. General.

(3) *Vid.* London Phil. Trans. for 1810.

also after the nerves which lead to it have been divided. The heart contracts chiefly in consequence of the presence of the blood, as has been proved by Baron Haller. When the contractions of the heart have become languid, or have ceased, they may frequently be renovated by inflating the lungs.

5th, The disposition of the muscular fibres of the heart is very peculiar; and, by their contraction, the included blood is expelled.

During this contraction, the apex approaches its base; the sides of the ventricles are drawn towards the Septum Cordis, which is more fixed; and, from the corresponding cavities being filled at the same time, and being united by a common septum, they must act at the same time.

The heart (as Harvey calls it, the *fundamentum vitæ, princeps omnium,*) is in the alternate state of contraction (or systole), and dilatation (or diastole), from the moment of our birth till the moment of death.

6th, During the contraction of the heart, it starts forwards, describes a portion of a circle, and strikes the side between the fifth and sixth ribs: this is to be imputed to the filling of the auricles placed at the base of the heart, and to the sudden dilatation of the arch of the aorta; the anterior part of which is moveable, but the posterior part is fixed down.

The auricles and ventricles are successively contracted and dilated.

Mr Brodie has drawn the following conclusions from his experiments.

"1. The influence of the brain is not directly necessary to the action of the heart.

"2. When the brain is injured or removed, the action of the heart ceases, only because respiration is under its influence; and if, under these circumstances, respiration is artificially produced, the circulation will still continue.

"3. When the influence of the brain is cut off, the secretion of urine appears to cease, and no heat is generated; notwithstanding the functions of respiration, and the circulation of the blood, continue to be performed, and the usual changes in the appearance of the blood are produced in the lungs.

"4. When the air respired is colder than the natural temperature of the animal, the effect of respiration is not to generate, but to diminish animal heat." *Vid.* Med. & Phys. Jour. Vol. xxvi. p. 67.

When, by the contraction of the auricles, the blood which they have received by the venæ cavæ and pulmonary veins is expelled, the ventricles are relaxed, and ready to receive the blood; and when the ventricles contract, and expel their contents into the pulmonary artery and aorta, the auricles are relaxed.

The heart is in a constant state of contraction and relaxation, and continues so for many hours in several of the amphibia, after it has been cut out of the body; and nothing can be more wonderful than the regularity, uniformity and constancy with which the alternate contractions and relaxations of the different cavities of the heart take place. From the earliest period of existence to the instant of death, they proceed in the same order, and occupy the same time, and, in short, were considered by the ancient anatomists and physiologists as incapable of explanation, and beyond the reach of human comprehension.

The great force with which the blood is expelled by the muscular power of the heart, is no less remarkable than the constancy and regularity with which its action takes place.

7th, In consequence of the contraction of the ventricles of the heart, the blood is thrown with considerable force into the pulmonary artery and aorta, and their ramifications; while the arteries, being exposed to the impluse of the blood from tne ventricles, are provided with coats of considerable strength; which, being muscular, assist the heart in propelling the blood; adapt themselves to the quantity of blood; and, in the case of bleeding, by their contraction stop the flow of blood.

8th, That there is a muscular contractile power proper to the arteries and veins, is evident from the experiments of Vershuir, my Father, Mr Hunter, Dr Wilson Philip, and Dr Hastings, and from the arteries of an animal bled to death, being much diminished in their diameter.

A. From the effects of local stimuli, which excite an increased action of the arteries.

B. From a hæmorrhagy being stopped by the contraction of the coats of the artery.

Dr Jones's experiments have thrown much light on this subject. They have proved, that bleeding is stopt by the muscular contraction of the vessels, by the retraction of the artery within its sheath, by the effusion of blood into the cellular membrane, by which the artery is connected with the neighbouring parts, which coagulates and presses on the orifice of the artery, and by the formation of a small conical coagulum within the artery, which adheres by its circumference to the cut or divided surface of the wounded vessel.

The vasa vasorum of the artery also pour out coagulable lymph, and thus the space is filled up between the external coagulum, and that within the artery; and, lastly, coagulable lymph is effused between the coats of the divided artery.

The arteries in the vicinity of abscesses in the lungs* and liver, are also occasionally filled by coagulable lymph, by which the bleeding, which otherwise must have occurred, is prevented.

C. From gangrene of the feet succeeding to ossification of the coats of the femoral artery.

D. From the circulation being continued when the heart is wanting, as in some fœtuses, and in many worms.

9. When the heart contracts, the arteries are at that instant dilated; and in this state we perceive their pulsatory motion. That the pulse is owing to the dilatation of the coats of the artery, may be made obvious (Bichat states) by transfusing the blood from an artery of a living animal into the humeral artery of a dead body, which thereby acquires pulsation.

That the pulse is not owing to the contraction of the coats of the artery, has been fully proved by Vesalius's experiments †.

10. If the laws of hydraulics are applicable to the arterial system, the blood, in consequence of its viscidity, of friction,

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* Vide Stark's Works, edited by Dr C. Smyth.

† Vide Vesal. de Corp. Human. Fabric. Lib. VII. cap. xix. p. 569. Lugdun. Batav. 1725.

of the angles and anastomoses of the arteries, of mechanical pressure, and of the greater area of the branches than of the parent trunk, should flow much more slowly in the smaller than in the larger trunks of the arteries.

The above holds true with regard to water contained in metalline tubes; but perhaps not with regard to blood circulating through the muscular and elastic bloodvessels of a living animal,—as has been proved by the experiments of HALLER * and SPALLANZANI †; who have stated, that they remarked the blood issuing as rapidly from the smaller as from the larger arteries.

11. The blood, which is distributed by the branches of the arteries, is brought back again by the veins, which are continued from the smaller branches of the arteries, as may be seen in the pellucid parts of animals; and, by throwing a penetrating liquor into an artery, it flows into the veins.

The smaller veins uniting, form the larger; whilst the larger, by their union, form the vena cava superior and inferior. The former brings back the blood from the upper, the latter from the under parts of the body to the heart.

12. The return of the blood through the veins to the heart is promoted by the muscular power of the vessels themselves, the action of the adjoining muscles, and pulsation of neighbouring arteries; and, perhaps, also by the column of blood in the veins, which, being always full, the effect of the stream of blood *a tergo*, must be considerable in pushing on the blood. The reflux of the blood through the veins is prevented by the valves within them.

13. The circulation of the blood is proved by the structure of the heart, arteries, and veins; and by ligatures.

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* Vide Element. Phys. Lib. 6. sect. 30.

† Vide his Experiments on the Circulation of the Blood. "I did not find" he observes, "that the blood, in passing out of the middle-sized arteries into their branches, experienced the least retardation from any difference in the capacity of the vessels, or the numerous angles they formed with one another; nor did the mode of circulation, whether languid or strong, oscillatory or intermittent, appear to be at all affected by multiplicity of natural and artificial curvatures, or the flexures and convolutions made by the different ramifications."

There are various causes which determine the blood to follow a particular course. By means of the contraction of the auricles, the blood flows into the ventricles, from which it is propelled into the two great arteries; and its reflux is prevented by the valves placed between the auricles and ventricles, and at the mouths of the pulmonary artery and aorta.

The different effects of pressure upon an artery and vein, afford incontrovertible evidence of the circulation of the blood.

A ligature thrown around the humerus prevents the flow of blood to the fingers, and causes also a swelling of the artery between the ligature and the heart. There is at the same time a swelling of the veins between the ligature and the fingers, the return of the blood towards the heart being impeded.

The circulation of the blood is visible by the aid of the microscope; it may be imitated by an injection thrown into the arteries; and it is also proved by the loss of blood an animal sustains by opening an artery, and by the injection of emetics and purgatives into the veins, which produce the same effects as when taken into the stomach.

14. From what has been said as to the structure, situation, and functions, of the heart, arteries, and veins, it is evident that these are much exposed to organic derangements.

15. The circulation of the blood is also proved by the effects of transfusing the blood from the vessels of one animal into those of another, which was formerly much practised in England and in France, in order to cure various diseases, and also to render the operation of medicines more rapid and efficacious. It may be added, that, at the Veterinary School at Copenhagen, it has been ascertained that medicines injected into the veins of horses produce their effects more rapidly, and in smaller quantities, than when otherwise administered.

The arteries are liable to fall into a state of aneurism.

By aneurism, is understood a diseased enlargement of a portion of an artery. Of this organic derangement there are the following varieties. In the first, the diameter of the artery is uniformly enlarged, constituting a round, circum-

scribed, pulsating tumour *; this forms what has been called the *circumscribed true aneurism.*

In some cases of this description, the tumour is of an oblong figure, not distinctly circumscribed; and hence has been called the *diffused true aneurism.*

In the second variety of aneurism, a sac is found attached to the side of the artery, with which it communicates by a narrow neck.

This kind of aneurism has been particularly described by SENNERTUS and SCARPA. The main trunk of the artery, to which the aneurism is attached, sometimes preserves its natural size; but on other occasions is considerably expanded †.

All aneurisms, according to SCARPA, are occasioned by a solution of continuity, or rupture of the muscular and innermost coats of an artery, which is occasioned by a wound, a steatomatous, or earthy degeneration, or a corroding ulcer: hence the blood is effused into the neighbouring cellular substance, which is condensed into a cyst.

In some rare cases the coats of an artery are extended partially in four or five different places, forming what has been called the *sacculated aneurism.*

My Grandfather has described what he has called a *mixed aneurism*, or that kind of aneurism which is formed by the rupture of the true aneurism, and the consequent effusion of blood in the adjacent cellular substance.

A dilatation of a cluster of the smaller arteries sometimes takes place, forming the *aneurism by anastomosis* of Mr JOHN BELL.

When an unnatural communication is established between a vein and the artery which lies under it, this has been called, by Dr W. HUNTER, the *varicose aneurism.*

A wound of an artery has been said, by authors, to form a *false aneurism.* The blood sometimes insinuates itself along the course of the principal artery and vein of the limb, constituting an irregular oblong aneurism. This has been called the *diffused false aneurism.*

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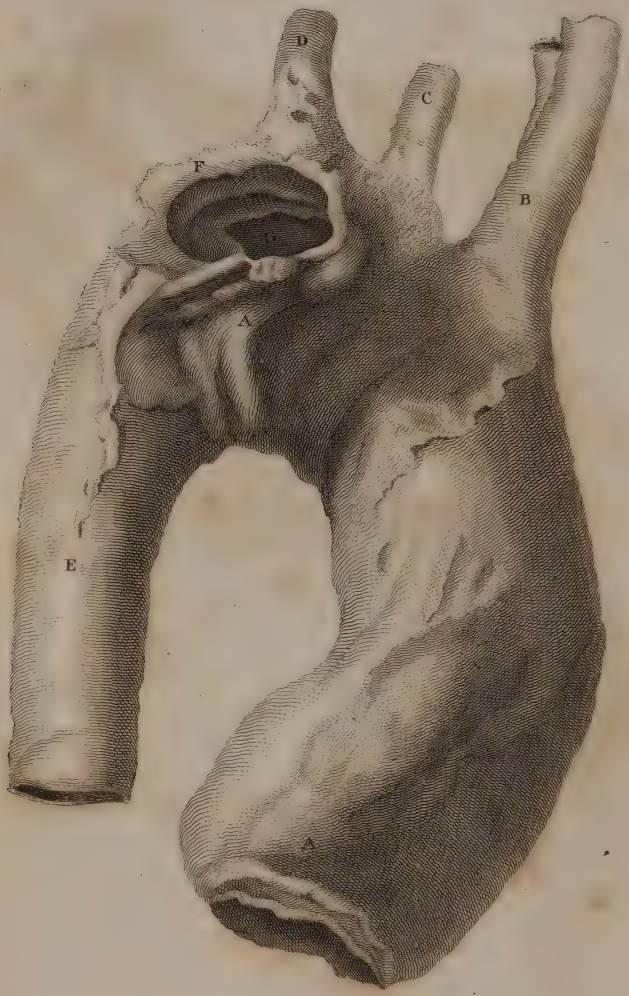
* Vide Plate II. † Vide Plate III.

TAB. III.

TAB. III.



The most frequent organic derangement of the vascular system is ossification. It occurs generally on the outer surface of the internal coat; and, in its incipient state, appears in the form of small points, or of thin bony shells.

Such ossifications more frequently occur in the semilunar valves, at the beginning of the aorta, or in the mitral valve at the mouth of the auricle, and are frequently attended with a dilatation of the diseased artery, and with an enlargement, not only in the capacity of the left ventricle, but of the substance and thickness of its muscular fibres.

Table II. represents an aneurism of the arch of the aorta, in which that artery, after having been considerably expanded, gave way nearer to its origin, and a considerable quantity of blood was effused into the pericardium. A, The aorta near to its rise from the left ventricle of the heart. B, The aorta very considerably enlarged. C, Points out the seat of the rupture of the aorta. D, The arteria innominata. E, The left carotid artery. F, The left subclavian artery. The aorta at the place on which the letter H is placed, is of its natural size.

Table III. represents an aneurism in the arch of the aorta, in which a portion of that artery is considerably enlarged: there was a small sac at the root of the left subclavian artery formed by the expansion of the outer coat of the artery, which gave way, and occasioned the instant death of the patient. Between the letters A and A, the aorta was enlarged. B, Is placed upon the arteria innominata. C, Points out the left carotid artery; and D the left subclavian artery. E, Points out the thoracic aorta, which is of its natural size. F, Points out the sac, which is formed by the external coat of the artery, and which burst suddenly, when the patient was at the water-closet.

CHAP. II.

OF THE ORGANS OF RESPIRATION.

HAVING, in a preceding Chapter, treated of the circulation of the blood, it is now necessary to direct the attention of the reader to the changes which the blood undergoes during the circulation; and of these the most striking is the change which the blood undergoes in the organs of respiration. The functions of circulation and respiration have an immediate relation and dependence upon each other; hence the structure of the organs of respiration is varied according to the nature of the apparatus by which the blood is circulated. Respiration cannot take place without circulation, and by it the blood is exposed to the influence of the atmospherical air.

The venous blood, though charged with the chyle, is inadequate to support the functions of the animal economy, unless it be exposed to the air; and hence, in all animals, the respiratory apparatus consists chiefly of a congeries of bloodvessels, to which the air has free access.

In the classes Mammalia and Birds, there are two circulations, a particular one through the lungs, and a general one through the body at large, for which purpose there are two hearts, viz. a *pulmonic*, and a *systematic* heart; by the former, the blood is sent into the lungs, where it is exposed to the influence of the atmospherical air, and is returned to the latter, completely changed in its properties, before being diffused over the body, by the branches of the aorta.

The lungs are spongy bodies, consisting of air-vessels, air-cells, bloodvessels, absorbents, and nerves, which are all involved in cellular substance and membranes.

The lungs occupy the larger share of the chest, and correspond with it in figure; they are nearly conical in point of form, the basis of which is undermost; they are convex before, behind, and laterally; and somewhat flattened on the side next to the mediastinum anterius, and heart, and concave where they are applied to the convex surface of the diaphragm.

The lungs descend much lower behind than before; they are nearly as low as the 12th rib, and consequently are more liable to be wounded behind than before. The lungs of the right and left sides are completely disjoined by the mediastinum arterius, and heart; and, therefore, the functions of the lungs of the one side are wholly independent of those of the other, and life may be continued by the lungs of one side only. Branches of the windpipe, bloodvessels, nerves, and absorbents, are common to both lungs. On the surface of the lungs there are a number of pale coloured lines, which define the smaller lobules of the lungs.

The lungs are divided by fissures, into lobes, which vary in depth, between which there is a large quantity of cellular substance; and these lobes are subdivided into lobules, between which there is also cellular substance. On the right side there are generally three great lobes, and on the left two lobes only; but I have also frequently seen three great lob s on each side; and in one instance, I met with five lobes on one side.

In consequence of inflammation, the lobes of the lungs often adhere to each other very intimately, so that even the marks of distinction between them are almost wholly obliterated. The lungs correspond in form with the sacs of the pleuræ in which they are contained, and hence those of the right side are broader and shorter than those of the left side,* on account of the diaphragm of the right side being more convex than that of the left. The lungs being compressible, may lose considerably of their bulk, when air, water, or purulent matter, has been effused into the sacs of the pleuræ, or when the heart or liver have attained an extraordinary bulk.

* Vide Engravings of the Thorax and Abdominal Viscera published by me in 1814.

In a living animal, the capacity of the lungs is constantly varying, as these organs follow the movements of the parietes of the chest during respiration.

The colour of the lungs varies according to the period of life, and quantity of blood they contain; during infancy, the lungs are of a light red colour, during manhood, of a greyish purple hue, and in old age they acquire a deep purple or brownish colour, and have a number of small rounded spots upon them, of a still darker appearance.

The lungs of the victims of the guillotine have been said, by the French writers, to be of a pale grey colour; but if we may form a judgment from the lungs of animals that have been killed by bleeding, the lungs still retain their purple hue. The sensation communicated by pressing the healthy lungs is very peculiar; they feel, as if filled by air, and they readily float on the surface of water; but I never could so far succeed in pressing out the air, as to take off the peculiar feel, or to make them sink in water. But when the lungs have been inflamed, they acquire the colour, consistence, and weight, of a portion of the liver, and readily sink in water *.

Of the Coats of the Lungs.

The lungs have two coats, which may be separated from each other in the fœtus, but which are inseparable in the adult. The external is the continuation of the pleura; it is very thin but dense. The inner coat covers the lungs, and insinuates itself between the lobes and lobules.

Besides these coats I saw, in one instance, a thin membrane, about the same thickness as the pleura, in which there were a number of bloodvessels, extending over the whole surface of the lungs of the left side, and it adhered, in some places, very intimately with the pleura covering the lungs. There were no morbid appearances which indicated previous inflammation.

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* According to Lecieux, there is sometimes a malconformation of the lungs. The average weight of the lungs in forty children, born dead at the full time, is about 801 grains, according to that author; but in five of these it was only 32, 19, 14, 13, and 10 grains, whilst the body was of the average size.

SECTION I.

OF THE LARYNX AND TRACHEA.

The air-tubes and air-cells may be said to be the basis of the lungs. The air enters the lungs through a cartilaginous tube, the uppermost part of which is called the *Larynx;* from this a tube descends, which has been usually called the *Trachea,* which divides into two great branches called *Bronchi,* which are subdivided into very minute branches through the substance of the lungs. The larynx is not only an air-tube, but is also the seat of the voice, and hence is of a complicated construction, and differently constructed in different animals.

Of the Larynx.

The larynx, which forms the fore-part of the pharynx, is placed between the os hyoides and upper part of the wind-pipe, and is a prominent feature of the neck of the male, forming the projection commonly called *pomum Adami.*

The size of the larynx is not uniform in all individuals of the same sex, age, and stature; it is not proportioned to the stature, and is in all much larger after than before puberty, and is more capacious in the male than in the female. Castration has a great effect upon the size of the larynx, as that of the eunuch is much less expanded than that of the more perfect male.

The larynx, in point of form, is symmetrical, and in shape somewhat resembles a funnel, the small extremity of which is conjoined with the trachea.

The cartilages of the larynx are uniform as to structure, and are united to each other by membranes, ligaments, and muscles, by which they are moved upon each other. Five cartilages have been described as being proper to the larynx; but of these, one, called Epiglottis, is merely the lid which covers the larynx.

Of the Thyroid Cartilage.

The largest cartilage has been called *thyroid*, from its supposed resemblance to a shield. It occupies the fore and lateral parts of the larynx, and consists of two wings, which are united before, and form that prominence in the fore part of the neck so remarkable in the male, called the *pomum Adami*, in the upper part of which there is a notch.

The wings of the thyroid cartilage, when spread out, are somewhat of a square form, and are externally concave, and their concavities lodge the thyro-hyoid muscles.

The superior surface of the thyroid cartilage is connected by a distinct membrane to the os hyoides; and, from its posterior cornua, there are two ascending portions, which are united to the os hyoides, by round ligaments.

The inferior surface of this cartilage is shorter than the superior, curved backwards, and united with the articulating surface of the cricoid cartilage.

Of the Cricoid Cartilage.

The cricoid cartilage forms the base on which the thyroid and arytenoid cartilages are fixed, by means of articular surfaces. This cartilage is circular, and narrower before than behind, where it rises up between the wings of the thyroid cartilage; and on this posterior part of the cartilage there are smooth surfaces, by which the arytenoid cartilages are articulated with the cricoid cartilage.

The posterior surface is divided by a ridge into two lateral cavities, for the crico-arytenoidei postici muscles.

The inferior part of the cricoid cartilage is placed horizontally, and is connected with the upper part of the windpipe.

The superior part of this cartilage is connected to the thyroid, by a distinct membrane. The back-part of this cartilage rises up between the wings of the thyroid cartilage, and the inferior portions are connected by small oblique ligaments to the thyroid cartilage.

The opening transversely the crico-thyroid membrane is called *Laryngotomy*, an operation which is rendered neces-

sary, when the passage for the air through the larynx is to a certain degree impeded.

Of the Arytenoid or Pyramidal Cartilages.

The arytenoid cartilages constitute the most important part of the larynx, being connected with the chords, upon the state of which the voice more immediately depends; and the movements of these cartilages tend also to the enlargement, or diminution, of the aperture of the glottis.

These cartilages are of a triangular figure, with their cartilaginous appendices, which are fixed to their apices, directed towards each other. The posterior surface of the arytenoid cartilages is filled up by the arytenoid muscles. The anterior surface is convex, with slight excavatures, which are occupied by the arytenoid glands. The arytenoid cartilages are connected to each other by the membrane of the larynx, and by muscular fibres; and also to the epiglottis, by a membranous fold on each side, which form the sides of the upper aperture of the larynx. On the above membrane a very few muscular fibres may be observed in very robust men, which have been described as muscles by some anatomists.

Of the Epiglottis.

The opening into the larynx is covered by the ligamento-cartilaginous substance, which in figure resembles the tongue, and which has been called the *epiglottis:* when raised it is placed perpendicularly; and when the tongue is depressed, it is pressed down, and covers the passage into the larynx, as in the act of swallowing.

The epiglottis is fixed by its under end, by means of a short ligament, to the middle notch of the thyroid cartilage; and it is connected laterally to the whole length of the arytenoid cartilages. There are a number of fissures or lacunæ, the orifices of the mucous follicles on the surface of that membrane which lines the epiglottis.

The epiglottis of different individuals varies as to its size and form. The surface of it which is next to the tongue, is somewhat convex, and the opposite surface next to the larnyx

is concave, and its border, which is thinner than any other part of the cartilage, is folded towards the tongue.

The epiglottis is connected with the mucous membrane of the tongue; it forms three folds, of which the middle one is the most conspicuous, and has been called by some authors *the frœnum epiglottidis.*

The epiglottis is not of an uniform thickness; it is rather thicker below than above.

The epiglottis is very elastic, and of a pale colour, when divested of its membrane, and in structure resembles the cartilages of the ear. There are a few scattered and pale coloured muscular fibres under the membrane, which connects the points of the arytenoid cartilages to the epiglottis; these, on account of their situation, have been called the *aryteno-epiglottoidei muscles.* In some individuals no such muscular fibres can be traced.

Of the Ligaments of the Larynx, or Vocal Chords.

The vocal chords, which are about half an inch long, take their rise from the fore part of the arytenoid cartilages, and extend backwards in a horizontal direction to the angle formed by the junction of the wings of the thyroid cartilage; and between these there is a chink called the *rima glottidis.*

When the larynx is inflamed, the rima glottidis is so much contracted as to give rise to difficult breathing. The patient inspires with difficulty, the voice has a croupy sound, but he expires readily.

There are also two vocal chords, which are somewhat larger than the preceding, which extend between the bases of the arytenoid and thyroid cartilages; and between the superior and inferior vocal chords there is a small cavity, capable of admitting the point of the little finger, called the *ventricle of the larynx.*

The larynx is lined by a very sensible mucous membrane, which forms opposite to the arytenoid cartilages a horizontal fold, that passes directly forwards, and is joined to the angle formed by the wings of the thyroid cartilage.

The membrane is continued downwards; it lines the cavi-

ties called ventricles of the larynx, and then forms a second fold, which bounds the ventricles below; and it also lines the vocal chords, and afterwards the trachea and its branches.

Of the Muscles of the Larynx.

The larynx is moved as a whole by the muscles proper to other parts; and its component cartilages are also moved upon each other, by muscles which are implanted upon it.

The greater number of the muscles of the larynx are connected with the arytenoid cartilages, to which the vocal chords are fixed. If the thyroid cartilage be moved forwards by the crico-thyroid muscles, and the two arytenoid cartilages be drawn backwards at the same time by the crico-arytenoid postici, the vocal chords must be made tense; and if, on the contrary, the arytenoid cartilages be moved forwards by the thyro-arytenoidei, these chords will be relaxed. If the arytenoid cartilages be drawn outwards, or separated from each other by the crico-arytenoidei laterales, the space between the vocal chords called *glottis* will be made wider, or dilated; and if, on the contrary, the arytenoid cartilages are drawn nearer to each other by the arytenoideus transversus, and the arytenoidei obliqui, the glottis will be constricted or shut.

Arytenoideus Transversus.

The fibres which constitute this muscle, are disposed transversely between the arytenoid cartilages, by which these cartilages are drawn close to each other; and hence the glottis is shut.

Arytenoidei Obliqui.

The arytenoidei obliqui extend from the base of one of the arytenoid cartilages to the point of the other; and the fibres of these muscles decussate each other like the strokes of the letter X. These muscles are subservient to the same purpose as the preceding.

Crico-Arytenoidei Laterales.

These muscles take their origins from the sides of the cri-

coid cartilage, where it is covered by the thyroid; and they are inserted into the sides of the bases of the arytenoid cartilages. These are the antagonists of the preceding muscles; by their co-operation they separate the arytenoid cartilages from each other, and dilate the glottis.

Of the Thyro-Arytenoidei.

These muscles, which take their rise from the under and back parts of the thyroid cartilage, or within the concavity of the thyroid cartilage, run upwards upon the side of the glottis and are inserted into the fore part of the arytenoid cartilages.

By these muscles the arytenoid cartilages are pulled forwards towards the thyroid, and the vocal chords are shortened.

Of the Crico-Thyroidei.

These muscles arise from the sides and fore-parts of the cricoid cartilage, and are inserted into the under parts and inferior cornua of the thyroid cartilage. These muscles pull the thyroid cartilage forwards, and stretch the vocal chord.

Crico-Arytenoidei Postici.

These oblique muscles arise from the back-part of the cricoid cartilage, and are inserted into the narrow extremity of the back part of the base of the arytenoid cartilage.

These muscles pull the arytenoid cartilages backwards; and when thrown into action at the same time as the crico-thyroid, the vocal chords are fully stretched, or made tense.

The larynx receives its blood by the medium of the superior and inferior thyroid arteries.

The veins which accompany these arteries are of a large size, and must be divided in opening the larynx; and from them a considerable quantity of blood has been in some operations lost, which, should it pass into the windpipe, might suffocate the patient.

The larynx has also a number of lymphatic vessels, which pass into the lymphatic glands of the neck.

The nerves of the larynx are derived from the eighth pair of nerves; and, it may be observed, that the superior and inferior laryngeal nerves communicate with each other.

Observations on the Physiology of the Larynx.

The larynx is subservient to two different purposes; it gives passage to the air which enters and issues out from the lungs, and it is the seat of the voice, as is evident from the loss of voice which follows the opening the windpipe.

In the higher orders of animals, there are all the requisites essential to the production of sound; lungs for the accumulation of air, a trachea or tube for the air, and vocal chords, capable of vibrating from the action of the air that is expired.

But fishes and insects are incapable of emitting a sound, as there is in them no magazine in which the air is accumulated.

It may be also observed, that the mere passage of the air through the glottis is not adequate to the production of sound, for the air during sleep passes through the glottis, but no sound is produced; the production of sound is therefore a voluntary effort.

The larynx is composed of elastic cartilages, each of which is well calculated for vibrating; and these cartilages are so disposed, that an aperture is always left between them for the air entering into and passing out from the lungs.

The sound of the voice is occasioned by the vibrations to which the air expelled from the lungs is exposed in passing through the glottis; which sound is modified by the varied form and dimensions of the parts of the glottis, and by the varied velocity and degrees of force with which the air passes through the glottis. Thus sounds are grave or acute according to the velocity of the vibrations of the vocal chords; and thus the intensity of the sound depends upon the extent of the vibrations, but on what the peculiar tone depends has not been ascertained.

The larynx has been compared to an organ, of which the lungs are the bellows, the trachea the pipes, and the throat and lips the keys.

It seems probable that the sound of the voice has some connection with the capacity of the larynx: hence the very remarkable acuteness in the sound of the voice, when the la-

rynx is raised, which is done to the extent of half an inch for each octave; and when a bass-note is sounded, the larynx is depressed again in a similar gradation. When the larynx ascends, it is elongated and contracted, and when it descends it is dilated. The above observation is applicable to the case of eunuchs, whose tones of voice and larynx resemble those of the female: hence also the similarity of the voice of infants of both sexes at the period of birth, their larynxes being similar in size and form: hence the cause of distinction between the sound of the voice in the different sexes after puberty,—the larynx being of unequal size in the different sexes. The human voice has been compared by some authors to a *flute*, by others to a *chorded instrument*.

The human larynx is, however, superior to all instruments made by human art.

It is composed of cartilages, so constructed, disposed, and articulated with each other, as to be susceptible of a great variety of motion; and which are affected by those slighter tremors of the air that do not in the smallest degree influence either a wind or chorded instrument. Besides, the vocal chords which alter and modify the tones of the voice are stretched in very various degrees by the muscles of the larynx, and are fixed to elastic and flexible cartilages; whereas the chords of all musical instruments are fixed to substances which possess those properties, so essential to harmony and variety of sound, in a very inferior degree.

The above opinion gains weight from the remarkable change the voice undergoes in old age.

In the old, the thyroid, arytenoid, and cricoid cartilages, are very frequently converted into bone, which, combined with the weakness and rigidity of the muscles, may explain the weakness and shrillness of the voice at that period of life.

But the epiglottis is very seldom ossified, otherwise we should be often exposed to be suffocated by extraneous bodies getting into the windpipe.

The sound originally formed in the larynx undergoes various modifications in its passage through the mouth and nostrils.

Lastly, the sound of the voice has been stated to be lost by dividing the recurrent nerves of the eighth pair.

It is difficult to explain from what cause the air passing through the human glottis, should produce a sound different from that of the inferior animals, and how each animal should have a peculiar sound of voice, when the differences in the structure are so trifling.

Of the Trachea, Aspera Arteria, or Windpipe.

The *aspera arteria* is a name given to the windpipe, on account of the inequality of its surface. It is so constructed as to be flexible, elastic, and at the same time almost incompressible, (excepting by great force), and, therefore, always open and pervious to the air. This tube is placed in front of the neck, and is slightly fixed to the neighbouring parts by cellular membrane. It takes its rise from the cricoid cartilage of the larynx, descends in the fore-part of the neck, and it is commonly said to be covered at its sides only by the sterno-hyoid and sterno-thyroid muscles, but in most individuals a very small portion only of the front of the windpipe is uncovered by these muscles. In its progress downwards it becomes rather smaller and inclines backwards, and when it reaches the chest, and is lodged between the layers of the mediastinum posterius, behind the arch of the aorta, and nearly opposite to the third vertebra of the back, it divides into two great branches, one of which is proper to the right, and the other to the left lungs: the former of these is the shorter and broader.

The cartilages which compose the windpipe are placed horizontally in respect to the axis of that tube; describe about three-fourths of a circle, are bent forwards in such a manner that the windpipe is convex in front, but latterly flattened, and their edges are opposed to each other, little space intervening between them. The windpipe at its back-part being destitute of cartilage, is flat, where it is in contact with the gullet. The cartilages of the windpipe are not uniform as to number, thickness or size, in all persons: they vary in number

according to the length of the neck, being generally in number between sixteen and twenty: they are about a line in breadth, about the fourth of a line in thickness, and sometimes they are forked.

The cartilages of the upper part of the windpipe are sometimes broader and farther distant from each other than those of the lower part of that tube.

Of the Coats of the Windpipe.

The windpipe has several coats. It has a cellular coat, and within, the chest is covered by the mediastinum posterius. The several component cartilages of the windpipe are covered and united by a very strong and very elastic ligament, which extends from the cricoid cartilage of the larynx to the smaller branches of the windpipe, the fibres of which follow a longitudinal direction; thus the windpipe may be occasionally elongated. There are two strata of muscular fibres, one of which follows the longitudinal direction, the other, or external, follows a circular course. By means of these coats, the windpipe is accommodated to the movements of the neck: to a certain degree it is elongated, and also contracted in its diameter, and the air in coughing is pressed out with greater force.

The trachea is lined by the continuation of the mucous membrane lining the windpipe; it is a soft, vascular and very sensible membrane, and connected loosely by cellular membrane to the muscular coat.

This coat is not of an uniform thickness in every part of the windpipe; in the branches it is thinner than in the trunks of that tube.

The inner surface of the windpipe is constantly lubricated by a mucous fluid, which is discharged by the orifices of ducts, which are obvious to the naked eye. They are most numerous, and also largest, in the back-part of the windpipe. After a successful injection, we observe that these mucous glands, in the coats of the windpipe, consist chiefly of a plexus of vessels, which form continuous canals with their excretory ducts. My Father also discovered a number of orifices of

mucous glands of a similar structure, grouped together between the cartilages of the windpipe, and which are so placed as to be slightly compressed, when the neck is extended or bent *.

It is a remarkable circumstance, that, though the larynx, trachea, and its branches, seem to be lined by the same mucous membrane, the different parts of it should not be equally liable to inflammation at the same period of life. In early life, that part of the mucous membrane which lines the windpipe is often inflamed; towards the meridian of life, that part of the mucous membrane which lines the larynx; and in old age, and also during infancy, the mucous membrane lining the smaller branches of the windpipe is no uncommon seat of inflammation. I am fully aware, that in the disease called *croup*, which prevails so much amongst children between three and ten years of age, the mucous membrane of the larynx is often inflamed, as well as that of the windpipe; and also that the inflammation often extends to the mucous membrane of the smaller branches of the windpipe; but still I have seen several instances in which the inflammation has been limited to the larynx, trachea or bronchi, and in patients of the different ages above named. The trachea divides nearly opposite to the third dorsal vertebra into its two great branches called *bronchi*, one of which passes to the right the other to the left lungs.

These branches are of unequal diameter and length: the left is the smaller and longer, and passes under the arch of the aorta, before penetrating the substance of the lungs, whereas the right enters immediately into the substance of the lungs. The bronchi are subdivided into branches before entering the lungs; the right divides into three branches, and the left into two branches only, which again are subdivided into still smaller branches, which are distributed through every part of the lungs, and each branch has its correspond-

* I have subjoined an engraving of these from the original drawing by Mr Donaldson, which was made forty years ago. Vide Plate IV. Fig. 7.

ing artery, vein and nerve *. The bronchi are similar to the trachea in structure, excepting in being completely surrounded by segments of cartilage, in order that they might not be compressed and rendered impervious by the weight of the lungs. These smaller branches of the bronchi terminate in the very small tubes commonly called *the membranous tubes*, which are continued from the bronchi to the air-cells. In the small branches of the bronchi, the orifices of the mucous ducts are by no means of the same size as in the trunk of the windpipe; they seem to be in proportion to the size of the canal with which they are connected. When the windpipe has been slightly inflamed, the mucus is at first secreted in larger quantity than is usual, but as the inflammation subsides, it assumes a greenish hue. We do not distinctly see muscular fibres in these, probably on account of their extreme small size; notwithstanding which, it appears probable to me, that they possess a muscular power to enable them to expel their contents accurately. It has been very generally supposed, that, in the spasmodic asthma, the muscular fibres of the bronchi occasion the difficulty of breathing. But the cartilaginous segments prevent them from being contracted to such a degree as to have this effect; and in the cells there is not only no appearance of muscular fibres, but after they collapse in moribund animals, no contraction is excited when these are stimulated, but a general contraction of them, and diminution of the cavity of the lungs, such as is supposed in asthmatic persons, cannot take place, unless the lungs were to act with such force as to separate themselves from the pleura costalis, by overcoming the whole weight of the atmosphere, and forming a void between them and the pleura costalis. The spasm, therefore, seems to be seated chiefly in the transverse and oblique arytenoid muscles of the larynx, which have the power of completely shutting the glottis.

In support of this opinion, it may be observed, that the asthmatic have a sense of suffocation about the larynx, and

* Vid. Plate IV.

that vapours which irritate the larynx, excite a sense of suffocation, and a fit resembling the asthma. An ingenious physician, Dr Carrick, who studied in this University, after having heard my Father mention the above opinion, put it to the test of experiment, by making an opening in the fore-part of the trachea of a living dog, and with a probe irritating the larynx and the bronchi.

The irritation of the larynx *produced instantly an asthmatic fit.* But the irritation of the bronchi did not affect the breathing, because, as I suppose, their muscular fibres are feeble, and the cartilaginous segments which surround them prevent them from shutting the passage for the air.

The diaphragm, the intercostal and abdominal muscles, act also irregularly and spasmodically in the asthma, and in some cases I have observed the cardia contracted, and the stomach distended with air during the asthmatic fit.

SECTION II.

OF THE GLANDS CONNECTED WITH THE LARYNX AND TRACHEA.

There are Glands of three different descriptions which are connected with the Larynx and Trachea, viz. Mucous Glands, the Thyroid Gland, and Bronchial or Lymphatic Glands.

Of the Mucous Glands connected with the Larynx.

On the side of the epiglottis, next the larynx, the orifices of a number of glands are visible, through which a mucous liquor is discharged.

There is a triangular space filled by cellular substance and small mucous glands between the ligaments, which connect the epiglottis to the notch of the thyroid cartilage, and to the under side of the os hyoides, and one which fixes the base of the os hyoides. This has been called the mucous gland of the epiglottis, and under the membrane of the arytenoid car-

tilages, there are several mucous glands which are grouped together, and of a pale red colour; these in some persons are much more conspicuous than in others, and have been called the *Arytenoid Mucous Glands.*

Of the Thyroid Gland.

The Thyroid Gland is loosely connected with the neighbouring parts situated immediately beneath the larynx, upon the uppermost cartilaginous rings of the trachea, and covered by the sterno-thyroid, sterno-hyoid, and omohyoid muscles. This gland is of a yellow or pale red colour, though supplied by numerous and large bloodvessels, but sometimes it is as red as a portion of muscle.

This gland varies in size very much in different individuals. It is generally larger in the female than in the male, and proportionally larger in the fœtus than in the adult. It is generally composed of two distinct lobes of unequal size, generally united by a small transverse flat band, the thickness of which is very various; but, in some cases, it resembles a horse's shoe, with the concavity directed upwards; and, in a very few instances, the middle portion is awanting, so that there are two thyroid glands.

This gland is covered by a condensed cellular sheath, within which there is in some cases a muscle, called by Haller the *Levator Glandulæ Thyroideæ*, and by Soemmering, the *Musculus Glandulæ Thyroideæ.*

The above muscle takes its rise from the base of the os hyoides; its fibres are expanded upon the thyroid gland, and by its action may tend to elevate this gland.

This is a conglomerate gland, the larger lobes of which consist of smaller lobules; but the smaller lobes are not so distinct as those of many other glands.

This gland receives its blood by four large arteries, which are derived from the external carotid and subclavian arteries. The corresponding veins, which are also of large size, terminate in the jugular and subclavian veins.

No excretory duct has hitherto been discovered.

Of the use of the Thyroid Gland.

A great many opinions have been entertained respecting the use of this gland, which the reader will find enumerated in the works of HALLER and SOEMMERING.

It must be acknowledged that we are still much in the dark as to the use of this gland.

Of the Bronchial Glands.

With the lymphatic absorbent system I shall treat of the large blue or black coloured glands at the division of the trachea, named by anatomists Bronchial, since I think the following circumstances prove these are subservient to the lymphatics.

In the *first* place, on squeezing these glands, after laying open the trachea, I do not not perceive that the smallest drop of the black matter enters the trachea. I cannot observe the smallest vestige of an excretory duct, on separating these glands from the trachea.

On tracing the lymphatic vessels of the lungs, I have found them terminate in these glands, and dispersed through them; and opening into their cells on one side, and coming out from their cells on the opposite side, in the very way the lymphatics enter, pass through, and come out of, the conglobate glands, in other parts of the body. Now, it is very improbable that these glands alone should so perform a double office of secreting one liquor, and transmitting another.

But if we, for these reasons, deny that the bronchial glands pour a liquor into the trachea, how are we to account for our coughing up a dark coloured matter, like that contained in those glands?

That, I apprehend, will admit of explanation on another supposition, viz. that the black matter is secreted by the vessels distributed through the substance of the lungs; I do not mean, by the small glands of the trachea before described, for these are always of a brown or ashy colour, and contain a pellucid mucus, but by vessels without a glandular appearance.

To confirm this notion, let us reflect, that, in adult persons,

who cough up this black matter, the lungs are of a black colour throughout all their cells. So that it may not seem improbable that some of this black matter passes into the cells, and gives colour to the mucus.

Further, though I observe bronchial glands deeper in the lungs, or farther from the trachea, than they are generally described to be, yet, I have not observed them in the distant part of the lungs; but on examining the contents of the most distant, and smallest branches of the trachea, I have found them tinged with black matter; but we cannot well suppose that this black matter, is tenacious and viscid, which is carried so far backwards from the large to the small branches of the trachea. We would rather believe, that anatomists have hitherto overlooked the true cause of the dark colour of the mucus and of the bronchial glands; in the *first* place, from their not observing that the lymphatic vessels pass through the bronchial glands; and, in the *next* place, from their not considering the lymphatics as the absorbent vessels of the lungs: and that the true cause of the blackness of the mucus, and of the glands, is not to be sought for, from any particular mechanism of these glands; but that this black matter is thrown into the cavity of the trachea and cells of the lungs, as well as into the interstices of all the fibres of the lungs; and that hence the mucus within the trachea directly receives its colour; and again, that the lymphatic absorbents of the lungs, carry it from the substance of the lungs into the lymphatic bronchial glands.

And to give convincing proof that this explanation, which occurred to me from the time I knew the bronchial glands to belong to the lymphatic system, is the true one, we may observe farther, that the colour of the bronchial glands always corresponds with that of the lungs. In children, where the lungs are brown, they are brown likewise.

In old subjects I have very often observed lymphatic glands, at a great distance from the trachea, as in the mediastinum, and on the pericardium, of the same black colour; yet there was no reason to suppose these performed any secretion, or in any way communicated with the trachea; and, in some subjects, I have seen this black colour in the lymphatic

glands, near the termination of the thoracic duct, which appeared to transmit some of the lymphatics of the lungs in their course to the heart.

Nay, I have at last, after looking for the appearance in several subjects, found a black matter in the lymphatic vessels of one subject, between the substance of the lungs, and the bronchial glands: and in another, without squeezing the glands, I observed some of the black matter between them and the heart.

SECTION III.

OF THE CELLS OF THE HUMAN LUNGS.

The preceding observations on the bronchial glands, and the following on the minute structure of the lungs, were written by my Father, and read to the Royal Society, at a meeting held January 1767. As they contain all the knowledge we now possess of the structure of the lungs, I trust they may not be unacceptable to the reader.

Upon examining the cells of the lungs when they have been filled with air, wax or quicksilver, they are found to be very small.

In a child of a year old, they are about the $\frac{1}{140}$th of an inch in diameter, and in an adult they do not exceed the $\frac{1}{100}$th or $\frac{1}{90}$th part of an inch in diameter. Their figure is irregular, and not the same in any two of them; vid. Plate IV. and V. The diameter of the branches of bronchi which open into the cells, is nearly equal to that of the cells, or in an adult these are somewhat more than the $\frac{1}{100}$th part of an inch in diameter *.

Each cell has not a branch of the bronchi opening into it. This, in the first place, might be inferred from observing, that if air is blown into a very small branch of the bronchi, it fills a much greater number of cells than are proportioned

* Dr Haller supposes they are so small as to be invisible.

to it, that is, the cells communicate with each other. Hence, there seems little occasion that each cell should receive a branch of the trachea; and, what is a more direct argument to this purpose, I find a considerable cluster of cells adhering to one small branch of the bronchi, and this small branch entirely spent on the innermost or deepest of these cells, and the outermost cells only communicating with it through the innermost. When we come to consider the communication of the lobules with each other, we shall find a further argument to the same effect. On opening the cells of the lungs near their surface, and injecting quicksilver, we see clusters of cells forming the lobules, and a great number of these joined form the five great lobes of the lungs, the surface of which is covered by the continuation of the pleura, and of the loose cellular substance, which, in the contained parts of the thorax, is on the outer side of the pleura; but which comes now to be interposed between the continuation of the pleura over the lungs, where it forms their outer membrane, and the substance of the lungs. The outer membrane of the lungs is thinner and more tender than the pleura in a child at birth, and the farther we advance in life, it becomes still thinner. Nay, it will be found thinner the farther we trace it from the root of the lungs.

The accompanying cellular substance is not so loose on the lungs as on the containing parts, and its threads become still shorter by age; hence, in an adult, the outer membrane of the lungs is more difficultly separable from the lungs by dissection. This cellular substance leaves the pleura or outer membrane, to insinuate itself deep into the interstices of all the lobules.

The proper cells of the lungs have been by some authors supposed to communicate with the cellular membrane which fills up the interstices of the lobules, whilst others deny that the lobules have any natural communication.

Both opinions are erroneous. In the first place, it must appear very improbable that nature should in us admit the air into two kinds of cells. In the next place, if the air got from the proper cells of the lungs into the interlobular cellular substance, what should hinder it to pass from that into

all the cellular membranes of the body, or to produce universal emphysema, just as, in the anasarca, the water gets along the cellular membranes of the pleura, into the interlobular cellular substance of the lungs, but does not, generally speaking, get into the proper cells of the lungs.

What has led authors into this opinion is, that they observed the air, on inflating a branch of the trachea, pass into the interlobular cellular membrane, and as, in making this experiment, they blew the air in with the force of their own lungs, they conceived there was no rupture of parts, because the air acted as much on their own lungs as on the lungs of the subject, without considering that their own lungs could not be distended so much as to be in danger of bursting, because they are supported by the containing parts of the thorax, whereas the lungs of the subject wanting that support, are stretched much beyond their natural tone, and, therefore, are easily burst; or that a living person can burst the lungs of a subject after cutting open its thorax, although the lungs of the subject be supposed firmer than those of the living person. And, in fact, I find, if the lungs are sound, that, after dissecting off their common membrane from the pleura, their proper membrane will confine quicksilver poured into one of the branches of the trachea, in such quantity as to distend all the proper cells as much as they are distended in life.

Or, if the intercostal muscles of a child are all cut off, and a tube fixed into the trachea, if you blow in air gradually, you will not find it get into the interlobular cellular membrane, although you distend the lungs till they touch the ribs on all sides.

Or if, without opening the thorax, you inject a mixture of wax and tallow well melted and coloured with vermilion, till you find a considerable resistance, that is, till the lungs are well filled with it, you will find the injection has been confined to the proper cells of the lungs.

Nay, I have sometimes, in trying this experiment on purpose, pushed the injection with force without afterwards finding any of the vermilion in the interlobular substance, but

every where the colourless materials were strained into the interlobular cellular membrane. The straining of the colourless materials shewed that the injected materials had been made very fluid and pushed with force; and, therefore, if there were natural and numerous passages for air from the proper cells of the lungs into the interlobular cellular membrane, they would have carried the very fine colouring powder along with them, as that will go as far as the air, especially considering the greater force with which it was pushed.

Though I have denied that the proper cells communicate with the interlobular cellular substance, yet I admit that the air naturally, or in a living person, passes from one lobule into another; for I find that all the lobules are connected to those next to them at their roots. A great many lobules are besides this connected to the neighbouring lobules about their middle, and a very great number of lobules are connected to each other by their extremities.

It is surprising that these connections, especially the last kind, which are very manifest, without dissection, on the surface of the lungs, should not have been more attended to by anatomists. In all these places, I find a number of cells of one lobule opening into those of the neighbouring lobule, without the intervention of the interlobular cellular membrane.

To ascertain the manner in which the lobules communicated, I have filled a lobe of the lungs from the trachea with quicksilver or wax, and then, by dissection, divided it into lobules; or, after filling the lobe with wax, I have dipped it into the corrosive acid, so as to destroy all but the wax; and have constantly found, that it is impossible to separate the lobules from each other, as deep as the branches of the bronchi or trachea which enter them, without cutting or tearing a great number of the proper cells of the lungs, which join the lobules to each other. Hence, air or quicksilver injected from a very small branch of the trachea into one of the lobules, in the most gentle and gradual manner, passes from that lobule into the neighbouring, and from these spreads so as to fill the whole lobe. These communications which cannot directly receive a branch from the trachea, furnish a further presump-

tive argument that many other cells have no branch of the trachea directly terminating in them.

In the human body the communications of the lobules are more numerous than in many quadrupeds, as in the *pecora*, and hence the division into lobules is less distinct and beautiful in us.

When we consider the explanation which has now been given of the intimate structure of the lungs, it appears that the internal surface of the air-cells is nearly *thirty times greater than that of the whole external surface of the body.*

Thus the air-vesicles being only one-eightieth of an inch in their diameter, there will be 512,000 of them in one cubic inch. If, next, we suppose that the cells are of a cubical shape, which we may do without a material error, the sides of the cells will be six times more numerous than the cells, or their number in a cubic inch will be 3,072,000; and if, from this number, we deduct one-third, on account of the holes by which the cells communicate with each other, two millions of membranes remain, each of them equal to the square of one-eightieth of an inch, or the surfaces of the whole will be equal to 312 square inches, or upwards of two square feet; and, as our lungs in a full inspiration contain about 220 cubic inches of air, *the whole internal surfaces of the lungs will be nearly equal to* 440 *square feet, or nearly thirty times greater than that of the whole external surface of the body*, which is generally supposed to be equal to fifteen square feet.

I found, that by the elegant subdivisions and folds of the membrane of the gills, in a large skate, their surface is nearly equal to the whole external surface of the human body.

Thus, in each side of the body of a skate, there are four double gills, or gills with two sides each, and one single gill; or there are in all eighteen sides or surfaces on which the bronchial artery is spread out. On each of these sides there are about fifty divisions, or doublings of the membrane of the gills. *(f)* Each division has on each side of it 160 subdivisions, doublings or folds, of its membrane; the length of each of which in a very large skate is about one-eighth of an inch, and its breadth about one-sixteenth of an inch. *(g)* So that

in the whole gills there are 144,000 subdivisions or folds, the two sides of each of which are equal to the sixty-fourth part of a square inch, or the surface of the whole gills in a large skate is equal to 2250 square inches, that is to more than fifteen square feet, which have been supposed to be equal to the whole external surface of the human body. When, after a good injection of the artery, a microscope is applied, the whole extent of the membrane of the gills is seen covered with a beautiful net-work of exceedingly minute vessels.

As fishes taint the water they respire, in nearly the same manner as we taint the air we breathe, it appears that some matter, either useful or hurtful, or both, is absorbed or carried off from their blood, as it passes through their gills.

As in many fishes there is a soft spongy organ within the air-bag, by which the elastic air seems to be separated from the other humours of the animal; so in our lungs, the branches of the pulmonary artery separate the air which has been fixed in our blood, and which, probably by some change it undergoes there, begins to be hurtful, and is therefore discharged.

Having explained all that relates to the air-vessels of the lungs, we are next to examine the circulating system, beginning with the chief system called Pulmonary. The pulmonary artery takes its rise from the upper part of the anterior ventricle of the heart; it is soon divided into two great branches, which supply the right and left lungs, and these are again subdivided into innumerable branches, which are distributed through every part of the lungs, and which compose an intimate net-work on the cells of the lungs. The coats of the pulmonary artery are thinner and more pliable than those of the aorta.

Though the pulmonary veins are smaller in proportion to the corresponding branches of the artery, than branches of veins are in other parts of the body, yet we will neither find this fact so important as it is supposed, nor have reason to adopt the explanation of the purposes it has been supposed to serve. The size of the branches of the pulmonary artery corresponds with the greater size of the parts on the right side of

the heart, that they may lodge the great quantity of blood which is accumulated, when the equal play of the lungs is any how interrupted, just as, in the diving animals, such as the seal, there are great dilatations in the vena cava. And the inequality of the play of the lungs perhaps makes these parts by use to bear a greater proportion to the left side, than they did originally.

Besides which, by making the pulmonary veins small, the blood passes more difficultly, or undergoes a greater compression; and it is manifest, that one great use of the lungs is, by agitation and compression, to produce some great change in the blood.

Perhaps, too, the blood being thrown with greater velocity through the straight pulmonary veins, may more powerfully stimulate the left side of the heart, and enable it to drive its blood with greater force through the wide extended system of the aorta.

From a considerable number of trials made with different injected materials, I have found, that the communications or anastomoses of the pulmonary artery, with its corresponding veins, are larger than in most other parts of the human body; and that, whilst a fine injection passes with much difficulty from arteries into the veins in many other places, a much less penetrating injection will go easily through the pulmonary system.

Having observed this much in general, I next endeavoured to subject the terminations of the pulmonary artery to the microscope, and for that purpose, after having made a coarse injection pass from the pulmonary artery into the vein, I kept the cells of the lungs inflated from the trachea, till the injection was quite cooled and consolidated.

In making these injections I likewise remarked, that the finer part of the injection without the colour readily passed into the cells of the lungs and trachea; and, when we consider the quantity of moisture discharged at every expiration, we may infer that the passages into the trachea are patulous and numerous. Again, when we consider the uncommon nature of this discharge, and that with the moisture, a

vast quantity of fixed air is evacuated, we will be apt to suppose that by this channel, air is extricated from the blood.

I have very frequently seen air within the vessels of the pia mater, and also on some occasions within the internal jugular veins. According to Dr Davy, " air seems to pass pretty readily (probably through the exhalants) from the air-cells of the lungs into the pleura." He inflated the lungs of a dog under water, by means of a double bellows, through the trachea,—and " air in exceedingly minute bubbles escaped from the surface of the pleura, covering one of the inferior lobes, of a large size *."

I have always found communications between the bronchial artery and pulmonary vein †, and hence it is vain with Van Swieten to suppose we may distinguish an inflammation of the pulmonary from that of the bronchial vessels, by external symptoms.

Notwithstanding that the whole mass of blood passes through the lungs, and that as much of the mass is circulated through the lungs in the same time, as through all the rest of the body; the lungs constantly receive from the aorta branches which are named *bronchial*, and which, we must therefore suppose, are of considerable use. Were such arteries seen on the lungs only, they might be considered as accidental, or that the aorta scattering branches on all sides, sent some of these on the lungs; but we find the like in the liver, which receives a vast quantity of blood from the veins of all the other chylopoetic viscera: also an artery from the aorta; nay, the heart receives blood to its right as well as left side, from the aorta, although, the pulmonary artery, but for some good reason, could as well, or better, have furnished it with a branch.

Hence, upon the whole, we learn, that, by circulation, the blood becomes unfit for the purposes of the animal econo-

* This paragraph was not written by my Father, nor the following note.

† Reisseisen observes, if matter of different colours be thrown into the bronchial artery and pulmonary vein, not only the inner surfaces of the bronchial tubes, but the vascular network, (formed by the smaller branches of the pulmonary and bronchial arteries, and the pulmonary vein), is also found to be tinged with both matters, and the roots of the minute veins may be seen inserted into the pulmonary vein.

my, and we take it for granted, that, during its passage through the lungs, it gets the addition of the somewhat which enables it to perform its necessary office.

Of the Nerves of the containing parts of the Thorax and Lungs.

The nerves of the containing parts of the thorax and lungs are derived from the paria vaga of the eighth pairs of nerves, and from the sympathetic nerves. They form considerable plexuses, called the Anterior and Posterior Pulmonary Plexuses.

From these plexus nerves are sent out, which accompany the branches of the bronchi, and of the bronchial and pulmonary arteries. The larger branches sink deeply into the substance of the lungs, and follow the bronchial arteries, upon the coats of which they are distributed, and are probably ultimately lost upon the very sensible mucous membrane which lines the bronchi, though, before reaching that membrane, they are so small as to be invisible by the naked eye. According to HALLER, the lungs receive fewer nerves than the muscles; he uses the word *paucissimi*, which is by no means appropriate, as there are two plexuses of nerves proper to the lungs; and, it may be added, that the nerves of the lungs are more numerous than those of the liver.

As coughing is readily excited, by many substances applied to the inner side of the larynx and trachea, which give little or no uneasiness when applied to the tongue, pharynx, or œsophagus, we learn that the membrane lining the larynx, trachea, and its branches, possesses a very considerable degree of sensibility, and must, therefore, be supposed very susceptible of inflammation, and its consequences.

The nerves of the pleuræ costales, and of the pleuræ pulmonales, which are probably derived from the proper intercostal nerves and eighth pair, are so minute, that it is very difficult, if not impossible, to trace them by dissection. My Father found, by the following experiment, that, in their sound state, they have very little sensibility. An elderly man, to whom he was called in 1769, in an effort of coughing, burst his lungs, and so great a quantity of air was effused into the cavity of the pleura, as to occasion such

a degree of suffocation, as rendered the paracentesis of his thorax necessary to save his life. After the perforator of the trocar which was employed, was withdrawn, and the air discharged, he introduced, through its canula a leathern bougie ten inches long, and turned it around within the cavity of the pleura, so as to touch both the pleura costalis, and pleura pulmonalis, without exciting coughing, or giving him such pain as to make him shrink or complain much.

In two cases, in which an incision, large enough to admit the finger, was made in the pleura, on account of empyema, my Father introduced a surgeon's probe, bent like a hook, into the cavity of the thorax, and with the point of it rubbed the pleura against the neighbouring rib, without exciting any considerable degree of pain to the patient.

Notwithstanding the small degree of sensibility of the pleuræ in the sound state of the body, yet the pleura is very often inflamed, which is accompanied by acute pain.

To prove this, my Father cut, and then turned outwards, a portion of the skin of the thorax of a pig like a flap, and then made an incision into the cavity of the thorax, large enough to admit the point of his finger. He remarked that the lungs were quite sound, and slid readily upon the pleura costalis. The portion of the skin which had been raised was replaced, and covered by a large piece of adhesive plaster.

The animal began to breathe with difficulty, and died 37 hours thereafter; and in that short space of time, the lungs, which had collapsed, were much inflamed, and the pleura pulmonalis had contracted partial adhesion with the pleura costalis.

Of the Effects of Respiration upon the Atmospherical Air.

The quantity of air which is inspired has been very differently rated. At an average about forty cubic inches of air are taken in at each inspiration.

Air that has passed through the lungs differs from atmospherical air, 1*st*, In containing a considerable proportion of carbonic acid gas, as was distinctly proved by Dr Black, by expiring through lime-water, which is thereby rendered turbid, the carbonate of lime being insoluble in water.

2*d*, The air that has been breathed contains less oxygen gas.

3*d*, The bulk of the respired air is somewhat diminished.

The quantity of air that is expired is nearly equal to that which is inspired. There is also a small quantity of an aqueous vapour discharged from the lungs.

Dr Edwards, the latest author on respiration, infers from his experiments: " L'oxigène qui disparaît dans la respiration de l'air atmosphérique est absorbé en entier. Il est ensuite porté en tout ou en partie dans le torrent de la circulation.

" Il est remplacé par une quantité plus ou moins semblable d'acide carbonique exhalé, qui provient en tout ou en partie de celui qui est contenu dans la masse du sang.

" En outre, l'animal respirant de l'air atmosphérique absorbe de l'azote ; cet azote est porté en tout ou en partie dans la masse du sang.

" L'azote absorbé est remplacé par une quantité plus ou moins équivalente d'azote exhalé qui provient en tout ou en partie du sang.

" Voilà quatre points fondamentaux : 1°, L'absorption de l'oxigène qui disparait ; 2°, L'exhalation de l'acide carbonique expiré ; 3°, L'absorption d'azote ; 4_0, L'exhalation d'azote. Les deux premiers relatifs à l'oxigène, soit pur, soit combiné ; les deux autres à l'azote.

" On voit par là que le jeu de cette fonction est beaucoup plus compliqué qu'on ne l'avait pensé ; que son importance est considérablement accrue, et quil doit résulter des diverses modifications de ces phenomènes principaux une multitude de rapports.

" Suivant cette vue, la respiration n'est plus un procédé purement chimique, une simple combustion dans les poumons, où l'oxigène de l'air inspiré s'unirait au carbone du sang, pour former de l'acide carbonique qui serait expulsé aussitôt ; mais une fonction composée de plusieurs actes : d'une part, l'absorption et l'exhalation, attributs de tous les êtres vivans ; d'autre part, l'intervention des deux parties constituantes de l'air atmospherique, l'oxigene et l'azote *."

* Vide Edwards de l'influence des Agens Phys. sur la Vie, p. 465. Paris 1824.

The blood is much changed during its passage through the lungs. When it enters the lungs, it is of a dark red or purple colour, intermixed with the white chyle. When it leaves the lungs, it has a bright red hue, and all traces of the chyle have disappeared. When it has reached the smaller branches of the arteries, it begins to recover the tint peculiar to it when it first entered the heart; and when at last it has reached the smaller branches of the veins, it has completely regained its purple colour.

These are the greatest changes which the blood is at present known to undergo during its circulation. Future observations, in a more advanced state of chemical science, will probably determine the precise changes it suffers in composition. That there is such a change is pretty certain, from a circumstance we are soon to mention, namely, that venous and arterious blood differ in their capacity for caloric. This cannot be produced without a very material alteration in chemical composition.

Lower seems to have been the first author who attributed the florid colour of the blood to the chemical action of the air on it during its passage through the lungs, which opinion he took up from experiments on animals: he observed the black colour of the blood in the pulmonary veins after respiration had ceased, and red colour of the blood when respiration was renewed.

If we inquire by what part of the respired air this change of colour is produced, we shall find that it is owing to the effect of the oxygen. Dr Priestley found, that the same changes take place in the colour of the blood out of the body, and even through the coats of the vessels, as when oxygen gas is applied to the veins of the back of the hand.

Dr Mayow of Oxford concluded *that a volatile spirit, one of the constituent principles of the atmosphere, was absorbed by the blood during its passage through the lungs;* an opinion which was adopted by Borelli and Willis.

Dr Goodwyn's experiments have thrown further light on this subject: he removed the breast-bones of several large dogs, and exposed the trunks of the pulmonary arteries and veins,

in order to distinguish the colour of the blood passing through them. By inflating the lungs he imitated inspiration, and observed, that, during the inflation, the blood in the trunks of the pulmonary artery was black, but in the trunks of the pulmonary veins it was florid; and when the inflation was intermitted for a minute, the blood in the trunks of the pulmonary vein became gradually black, like that in the arteries.

My Father suggested to Dr Goodwyn a number of experiments which that gentlemen executed. The following is an exact copy of the manuscript in my possession.

" In consequence of your obliging suggestions I made the following experiments, which seem to me to strengthen the opinion I have advanced in my Thesis.

" *Experiment* 1.—I took out two circular pieces from one side of the skull of a dog, with a trepan, and without wounding the dura-mater. Immediately after I took out two similar pieces from the other side, so as to expose a large surface of the brain covered with the dura mater. *We saw the alternate elevation and depression of the exposed surface, and these motions were synchronous with the motions of respiration, and proportionate also to the degree of inspiration and expiration.* Ten minutes afterwards I introduced my thumbs at the openings on each side, upon the surface of the brain, and passed them entirely under the bone of the skull, compressing the volume of the brain and cerebellum at least to nine-tenths of its ordinary extent. The animal immediately uttered several cries, and the muscles of voluntary motion were suddenly contracted; the respiration was a little increased; and the pulse more frequent. About two minutes after, the animal had lost its power of voluntary motion; and, as far as we could distinguish, its sensibility. *The respiration became deep and slow, the pulse less frequent and more full, and a stupor immediately followed.*

" This compression on the brain was continued about forty minutes; and all the symptoms just described remained during the whole time without any particular alteration.

" As soon as I removed the compression, the substance of the brain gradually returned to its original bulk, and the animal recovered by slow degrees its sensibility and voluntary motion.

" This was repeated on two other dogs with the same effects. In one of them I took out the two hemispheres of the brain while the animal remained alive, and pressed strongly with my thumb upon the cerebellum; *the sensibility and power of voluntary motion were instantly suspended*, but the pulse and respiration remained; and the animal continued in this state for more than fifteen minutes, till it seemed to be exhausted by the hæmorrhage.

" The intention of these experiments was to ascertain whether this alternate motion of the brain be essential to the life of the animal; and whether the involuntary motions of the animal would continue when any considerable compression was suddenly applied to the substance of the brain.

" *Experiment 2.*—I exposed the intercostal nerve and parvagum of a dog, about an inch below the larynx, and cut out nearly an inch of their trunks on both sides; immediately after the excision *the respiration became irregular*, and the animal made several violent struggles. I then closed the wound, and set the animal at liberty. He walked about as usual, and seemed to have no other inconvenience than *a deep inspiration*, with *a slow and laborious expiration*, which continued for several hours after.

" At seven the next evening I divided the spinal marrow between the second and third vertebra of the neck, in order to intercept all communication between the brain and thoracic viscera. The animal had some convulsive motions, and lost immediately all power of voluntary motion; but there was a feeble respiration, and a slight pulsation of the heart and arteries. About a minute after the division of the spinal marrow, I raised up the sternum, and exposed the thoracic viscera to view; *the heart was still beating feebly. Immediately after I applied my bellows to the trachea, (which I had before detached from the larynx), and inflated the lungs alternately as in respiration. The blood passed into the left ventricle extremely florid*, and the heart contracted with more force and frequency, and the pulsations of the arteries were distinctly felt in the thigh. This alternate inflation of the lungs was continued re-

gularly; and the contraction of the heart and arteries remained strong, until the end of ten minutes, when *they began to diminish gradually in force and frequency, and at the end of fifteen minutes from the beginning to inflate they ceased entirely;* nor could we renew the contractions of the heart, although we forced into the left ventricle *a great quantity of very florid blood.*

On examining the heart we found that the strongest stimuli, either chemical or mechanical, would not produce the smallest motion on its fibres.

This was repeated on two other dogs, with nearly the same effects.

One important conclusion from this experiment is, that the quantity of irritability which the heart contains, independent of its communication with the brain, is sufficient to enable it to carry on the circulation for some time; and another is, that artereal blood will exhaust this irritability more completely than any other stimulus.

"*Experiment 3.*—I repeated the second experiment upon a dog, in all the circumstances, as far as the removal of the sternum, and with the same general effects. As soon as the sternum was raised, and the trachea detached, I inflated the lungs with fixed air, in the same manner as I did in the other experiment with atmospheric air. The blood, which passed by the left auricle of the heart became immediately dark coloured; the heart contracted feebly for four or five times, and then ceased. We continued these alternate inflations for some minutes after, and saw the left auricle and ventricle greatly distended with blood, but they contracted no more. I applied the point of my knife to the heart, and it contracted in a convulsive manner. I then emptied it of its black blood, and applied other stimuli to it, and it contracted feebly for some minutes.

"This was repeated on another dog, and with the same effect.

"On a third dog also I repeated the same experiment; and as soon as the heart had ceased to contract, and appeared distended with this black blood, I emptied the lungs of their fixed air, and distended them with common atmospheric air,

as in ordinary respiration. The heart began to contract feebly again, and continued to contract for several minutes, till it lost its irritability entirely.

" From these few experiments it seems I think highly probable, that the fixed air taken into the lungs does not exert a noxious power upon the nerves of the lungs, or by their medium upon the brain.

" 2. That it either communicates some quality to the blood as it passes through the lungs, or prevents the communication of that quality, which it receives from the atmospheric air.

" 3. That the blood passing through the lungs in this state does not destroy the action of the heart, by any stimulating power which it possesses ; nor by any property noxious to the vital principle ; but by being incapable of exciting it to action."

The influence of the air upon the blood, as it passes through the lungs, is rendered obvious by those cases in which there is the foramen ovale and canalis arteriosus open. In these instances the skin has a purple hue ; it is colder than usual ; the digestion goes on ill ; and syncope occurs, together with the other symptoms of imperfect oxydation of the blood.

I have seen persons inhale for a short time air containing a much larger proportion of oxygen than atmospheric air.

By breathing oxygen gas, the pulse is accelerated, it is also made hard and strong, the spirits are elevated, we have a greater disposition to muscular action, and a beautiful glow of red is produced on the cheeks ; after some time a febrile heat is excited, and symptoms of synocha. That an encreased action of vessels takes place by inhaling oxygen was to me very evident, in the case of a man who had an ulcer on his leg, from which there was a discharge of a serous fluid, after he had inhaled the oxygen for a few minutes.

An animal, according to Beddoes, died in oxygen gas in a few hours, with all the symptoms of synocha ; on dissection all the parts were found of a bright red colour, even the liver. This cannot be owing to the colour of the blood in the vena portarum, but it must be from the blood of the hepatic artery ; and black livid spots were found on the intestines, like those produced by gangrene.

When equal parts of oxygen and azotic gases were inspired the same appearances took place, though in a less degree.

The following remarks of Dr J. Davy upon the absorption of gases, may probably through light on the change which the blood undergoes in passing through the lungs; if it be admitted that air is absorbed by mucous as well as by serous membranes. "Atmospheric air was injected into the pleura of a dog, and the opening through the parietes of the chest closed by suture; at the end of forty-eight hours the animal was killed. An hour after, the pleura was opened, and about eight cubic inches of air were collected, which shewed slight traces of carbonic acid gas, and consisted of ninty-three of oxygen, and seven of azotic gas, in the hundred." Dr Davy concludes from this experiment, that a greater proportion of oxygen was absorbed than of azotic gas.

"It may be said that the experiment does not warrant the inference that any azote was absorbed, and, consequently, that the expression "in a greater proportion" is incorrect. The absorption of this gas is probable, however, though not demonstrated in the present instance, as Sir Astley Cooper has found that common air introduced into the cellular membrane, and into the cavity of the thorax and abdomen of dogs, is, after a certain time, entirely removed by absorption *.

"Relative to the source of the carbonic acid gas, it is easy to conceive that it was formed, or emitted, in the air-cells of the lungs, as in ordinary respiration; and that, mixing with the air inspired, it was received into the pleura. If thus derived, and not from the surface of the pleura by secretion, it seems to follow, that it is less readily absorbed by the pleura than oxygen. To endeavour to decide this point, the following experiment was made.

"About thirty cubic inches of air, consisting of eighty parts common air and twenty carbonic acid gas, were passed from a receiver into a bladder, furnished at one extremity with a stop-cock, and at the other with a small trochar; both air-tight. A small incision having been made through the inte-

* Surgical and Physiological Essays by John Abernethy, p. 55. London, 1793.

guments of the right side of the chest of a dog, the trochar was passed through the intercostal muscles into the pleura. The stilette was immediately drawn from the canula into the bladder, and the air of the bladder instantly rushed into the pleura, and, on expiration, was in part forced back into the bladder. The exact quantity of air retained was not determined; it must have exceeded at least ten cubic inches. As speedily as possible the canula was withdrawn, and the external wound carefully closed by suture. The health of the dog was very little impaired by this operation. Two days after, when the animal appeared to be quite well, a similar experiment was made on the left side of the chest, and a mixture, consisting of seventy-five parts common air and twenty-five carbonic acid gas, was introduced into the pleura.

"The power exhibited by the pleura in the preceding instances of absorbing gasses, and the manner in which it exercised that power, in a greater degree, on one air than on another, and that in no ratio to their solubility in water, appeared to me so interesting and novel, that I was induced to prosecute the subject a little farther. With the same apparatus, I made similar experiments on the admission of three other gases into the pleura of dogs, viz. hydrogen, nitrous oxide, and nitrous gas.

"The obvious results of these two experiments on the same dog, are, 1*st*, The absorption of the greater part of the carbonic acid gas, and the whole of the hydrogen introduced into the pleura, and the appearance, *de novo*, of a considerable quantity of azote: 2*dly*, The death of the animal in the space of five hours from the time of admission of the nitrous gas and azote into the opposite pleura, the absorption of the greater part of the former gas without inflammation of the membrane with which it was immediately in contact, and the production of a peculiar change in the blood.

From what has been stated it follows, 1st, That the blood, in passing through the lungs, undergoes a most remarkable change in its properties, or is changed from *venous into arterial blood.*

2d, That respiration is one of these functions on which life more immediately depends.

Some difference of opinion has existed, and I believe still exists, as to the length of time this function can be suspended; and statements of persons remaining under water for half an hour, or even for three quarters of an hour, and afterwards having been restored to life, have been published. This is a point which it is most important to ascertain, as a surgeon, proceeding under the impression that life may be restored after half an hour, may neglect having immediate recourse to those remedies which are most essential to the recovery.

My Father therefore made several experiments with the view to determine this point; and he invariably found that, if the breathing of a quadruped be suspended *completely* for five or six minutes, it is impossible to restore it to life. Birds were killed in a shorter time.

From what has been above stated respecting respiration, it also follows, that nothing is more conducive to the resuscitation of the vital spark, when nearly extinguished by the inhalation of deletereous gases, by suspension, or by submersion, than the inflation of the lungs with pure atmospheric air.

At the suggestion of Lord Cathcart, Dr Cullen wrote a letter to his Lordship, published in Edinburgh in 1774, respecting the best means of recovering persons supposed to be drowned, of which the following is an extract.

" On this subject I am obliged to my learned and ingenious colleague, Dr Monro, who has made some experiments for ascertaining the best manner of inflating the lungs of drowned persons. By these experiments he finds it may be more conveniently done, by blowing into one of the nostrils, than by blowing into the mouth. For blowing into the nostril, it is necessary to be provided with a wooden pipe, fitted at one extremity for filling the nostril, and at the other, for being blown into by a person's mouth, or for receiving the pipe of a pair of bellows, to be employed for the same purpose. Dr Monro finds, that a person of ordinary strength can blow into such a pipe, with a sufficient force, to inflate the lungs to a

considerable degree; and thinks the warm air from the lungs of a living person will be most conveniently employed at first; but, when it is not soon effectual, in restoring the respiration of the drowned person, and that a longer continuance of the inflation is necessary, it may be proper to employ a pair of bellows, large enough at once to contain the quantity of air necessary to inflate the lungs to a due degree.

" Whether the blowing in is done by a person's mouth, or by bellows, Dr Monro observes, that the air is ready to pass by the gullet into the stomach; but that this may be prevented, by pressing the lower part of the larynx backwards upon the gullet. To persons of a little knowledge in anatomy, it is to be observed, that the pressure should be only on the cricoid cartilage, by which the gullet may be strained, while the passage through the larynx is not interrupted.

" When, by blowing thus into the nostril, it can be perceived, by the raising of the chest or belly, that the lungs are filled with air, the blowing in should cease; and, by pressing the breast and belly, the air received into the lungs should be again expelled; then the blowing and expulsion should be again repeated; and thus the practice is to be continued, so as to imitate, as exactly as possible, the alternate motions of natural respiration.

" It is hardly necessary to observe, that, when the blowing into the nostril is practised, the other nostril and the mouth should be accurately closed.

" If it should happen, that, in this practice, the air does not seem to pass readily into the lungs, Dr Monro informs me, it is very practicable to introduce directly into the glottis and trachea a crooked tube, such as the catheter used for a male adult. For this he offers the following directions: The surgeon should place himself on the right side of the patient, and introducing the fore-finger of his left hand at the right corner of the patient's mouth, he should push the point of it behind the epiglottis; and, using this as a directory, he may enter the catheter, which he holds in his right hand, at the left corner of the patient's mouth, till the end of it is passed beyond the point of his fore-finger; and it is then to be let

fall, rather than pushed into the glottis: and through this tube, by a proper syringe applied to it, air may be with certainty blown into the lungs. I observe, that some such measure had been proposed by Mons. Le Cat in France; but I have not learned that it has ever been put in practice, and I am afraid it may be attended with several difficulties, and must be left to the discretion of surgeons, who may be properly provided and instructed for this purpose."

The injection of stimulants into the stomach is also a powerful auxiliary.

In my Thesis de Dysphagia, published 1797, I have described, at considerable length, and also represented by an engraving, an apparatus, which is adapted not only to the injection of stimulants into the stomach, but also to the extraction of these from the stomach, after they have been thrown in, and have mentioned cases in which that instrument had been employed by myself: one of the cases was very striking. A woman afflicted with palsy of the gullet in our hospital, received her nourishment by that instrument for five years. Mr Jukes has lately published a description of an apparatus subservient to a similar purpose.

From what has been stated in respect to the lungs, it follows that these must be very liable to fall into a diseased state; and also that it is more difficult to remove diseases of the lungs than of most of the other bowels.

This is owing to the inhalation of noxious particles, together with the air into the cells of the lungs, and to exposure to sudden alternations of cold and hot air.

Inflammation of the lungs is extremely frequent in our variable climate; and the lungs, when so diseased, bear a strong resemblance, in consistence and colour, to the liver, being redder than the healthy lungs, and so solid as to sink in water. The inflammation is on some occasions general, on others partial; and the inflamed part is frequently covered by a layer of coagulable lymph, the thickness of which varies in different cases, by which the lungs are firmly fixed to the pleura costalis.

The inflammation of the lungs is often accompanied by an

inflammation of the pleura, and by an effusion of turbid serum into the sac of the pleura of the affected side.

Abscesses of different sizes, and also effused blood, have been found in different parts of the substance of the lungs; and when the pus is lodged in the cavity of the pleura, the disease has been called *Empyema*.

The lungs have been sometimes, though very rarely, reduced to a state of gangrene.

Tubercle is the most frequent organic derangement of the lungs, of which Dr STARK has given the most accurate account. Tubercles, according to Dr STARK, are generally seated in the upper and posterior parts of the left lungs, are of a whitish colour and cartilaginous consistence, and, when small, are solid, and always found in the cellular substance of the lungs, and often in clusters *.

At first they are very small, commonly numerous; and, when they attain a certain size, matter forms in them.

Noxious matter, when absorbed, is conveyed in the first place to the lungs, and if any other organ of the body be in a diseased state, the lymphatic vessels carry the particles that have been absorbed to the lungs, or, if the lungs themselves be diseased, every particle of matter absorbed from them is directly returned upon these.

Diseases of the lungs are with great difficulty removed, owing, probably, to the communication of the air-vessels of the lungs with each other.

When we consider the great importance of the functions of the lungs to the animal economy, it follows, that, if their functions are perverted, the whole body must be affected.

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* Some authors have supposed tubercles to be diseased lymphatic glands; though anatomists have not hitherto detected lymphatic glands in the healthy lungs; and for the following reasons.

1. Because disease has discovered lymphatic glands and lymphatic vessels in many parts of the human body, which had been supposed to be destitute of these.

2. Because tubercles of the lungs bear a striking resemblance to the lymphatic glands in colour and consistence, and to other diseased lymphatic glands, as those of the mesentery and neck.

3. As tubercles are often observed in clusters like diseased lymphatic glands.

4. As tubercles undergo the same morbid changes as diseased lymphatic glands; and, where diseased, are filled by similar contents.

A substance similar in colour and consistence to the spots on the surface of the lungs, is sometimes formed upon the surface, or within the substance of the different bowels; and even within the muscles and bones. This substance when minutely examined, is not found to be invariably of the same colour: it is in some instances very like to powdered charcoal and water, in others it has a purplish or reddish hue, and it is contained in distinct cysts of different sizes, varying much in point of size. These cysts are in many instances grouped together, and bear no distant resemblance to a bunch of dark purple grapes, and in some instances have distinct narrow necks.

I have also seen the black substance intersected by a number of white lines of a pulpy consistence.

The black matter is deposited in the manner above described, on the bones, serous membranes, in the cellular membrane, or within the eye ball and substance of the healthy viscera, does not give rise to any one morbid symptom. But it is often deposited when the patients were at the same time afflicted by fungus hæmatodes, or scirrhus.

This disorder is not peculiar to man. Mr Burt, veterinary surgeon, assures me, that he had often seen it in horses on the continent, and Dr Hannay informs me that this disorder occurs among horses and swine in the Stewartry of Kirkcudbright.

I owe my first acquaintance with this disorder to the late Mr A. Burns of Glasgow, who shewed me the eye of a child filled by it.

Soon afterwards, (about sixteen years ago), I saw a portion of the liver, about the size of a shilling, filled with a substance very like to China ink. The patient, a child of eight years of age, died from fungus hæmatodes of the eye. I have since seen the black matter in a fluid state, when it very much resembled the ink of the cuttle fish: it was contained in distinct cysts of different sizes, which were imbedded within a scirrhous mamma, which had been extirpated. Mr P. Syme, in the year 1808, made for me a beautiful drawing of the deposition of this black matter in the substance of the lungs, part of which had attained the consistence of cartilage.

This disease is not limited to a part of a peculiar structure. In a most remarkable instance of this disease which occurred to my colleague Dr Home, who was so polite as to send the morbid parts to the Museum of the University, for my examination, the bones, cellular membranes, fatty substance of the omentum, the muscles, the serous membranes of the bowels of the thorax and abdomen, and the internal parts of these, had more or less of the black colour.

The organs of generation are not exempted from the same disease. Dr Alison sent to me the ovaria which are much enlarged and studded over by small black coloured tumours, and when divided they were found to consist of cysts filled by a black fluid *. Within these few months I saw an old woman, who has a number of black coloured tumours on different parts of the surface of her body, and who probably labours under the same disease internally.

Tab. IV. fig. 1, 2, 3, represent the ultimate branches of the trachea filled with wax, and fig. 4, 5, represent the same magnified to about eight diameters.

The object of fig. 6 is to represent the mucous glands A A, in the back-part of the windpipe, and the small mucous glands disposed in rows upon the inner membrane, and which are seen after having thrown a penetrating injection into the bronchial arteries, and after raising up the cartilages of the windpipe marked B B B.

Fig. 7 gives a back view of the larynx. A A The thyroid cartilage. B The epiglottis. C C The broader and posterior part of the cricoid cartilage. D is placed on one of the arytenoid cartilages. E a small ligament passing between the cricoid and thyroid cartilages.

Tab. V. fig 1. and 2. represent the lobules and cells of the lungs of an adult of their natural size, filled with wax.

Fig. 3. and 5. represent the cells, viewed with a glass that nearly doubles their diameter.

Fig. 6, 7 and 8, represent the cells of their natural size, cut after inflating and drying them.

* Vide a valuable paper on Melanosis by Messrs Cullen and Carsewell, Medico-Chir. Trans. of Edin., vol. i.

TAB. IV.

Fig. 1.

Fig. 6.

Fig. 2.

Fig. 4.

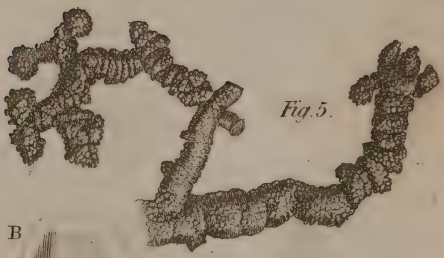

Fig. 5.

Fig. 3.

Fig. 7.

TAB. V.

Fig. 1.

Fig. 6.

Fig. 3.

Fig. 4.

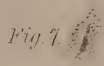

Fig. 7.

Fig. 5.

Fig. 2.

SECTION IV.

OF THE STATE OF THE CIRCULATING SYSTEM OF THE FŒTUS.

Before concluding respecting the organs of circulation, it seems necessary to subjoin a few observations respecting the state of the circulating system of the fœtus.

The heart and arteries of the fœtus are proportionally larger than in the adult: the arteries are also more numerous, and their coats are more elastic and tougher. The heart of the fœtus is more rounded, and is not placed so obliquely as in the adult. But the size of the arteries of the fœtus is not uniform through the whole body; it is proportioned to the development of the particular organs. Thus those of the brain, spinal chord, thymus gland and liver, are in the fœtus of a greater proportional size than in the adult, whereas those of the pelvis are proportionally of less size, with the exception of the umbilical arteries.

In the fœtus there is a greater number of small arteries near to the surface of the body, than in the adult, and the skin, at the period of birth, is of a red colour.

There are other peculiarities as to the circulating system. Thus, in the fœtus, the ophthalmic artery is proportionally larger, and those branches of it which are distributed upon the capsule of the crystalline lens are so large as to admit the red blood or red powder of vermilion; but, in the adult, they are so small as to receive only the more watery and colourless part of the blood.

It has been already observed, that there is in the adult a particular circulation through the lungs, and a general circulation through the body at large. But as the fœtus in utero does not breathe, there can be said to be, at that period, only a circulation through the body at large; for a very small quantity of blood, such only as is sufficient for their nutrition, passes through the lungs, in the fœtal state; the greater share of the stream being diverted from that organ, by a direct com-

munication between the auricles of the heart, called the *Foramen ovale*, and by a duct between the pulmonary artery and aorta, called the *Canalis arteriosus*.

The foramen ovale is nearly equal in size to the mouth of the vena cava inferior; it is not a direct, but an oblique passage, and, therefore, when it is pressed on each side, by the blood of each auricle, this passage is readily obliterated by the agglutination of its parts.

Most authors have described the Eustachian valve, placed at the opening of the vena cava inferior, as being more perfect and larger in the fœtus than in the adult; but I have met with many exceptions to that observation, and have also remarked, that where the auricle of the adult is unnaturally expanded, the same happens to the Eustachian valve.

The pulmonary artery of the fœtus, divides into three branches of unequal size; the largest, called *Ductus arteriosus*, passes obliquely downwards, and joins the thoracic aorta.

By the foramen ovale, and ductus arteriosus, a considerable proportion of the blood is diverted from the lungs: the blood is thereby impelled, with greater force, into the aorta, by the contraction of the heart; and hence the blood more readily reaches the placenta, by the medium of the umbilical arteries.

If the foramen ovale, or canalis arteriosus, had been awanting, the right and left sides of the heart must have given passage to unequal quantities of blood.

The blood of the fœtus is circulated in the following manner.

The arteries called Umbilical, which take their rise from the posterior iliac, ascend at the sides of the bladder, and pass through the navel, and being continued along the navel-string, or umbilical cord, in which they describe, in their progress, turns like those of a cork-screw, are ultimately divided into a great many branches, which are distributed through the *afterbirth* or *placenta*.

The placenta serves to the fœtus the same office as the lungs to the adult.

Professor JEFFREY of Glasgow made a number of obser-

vations upon the colour of the blood of the umbilical vein, and found it to be of a brilliant red colour, like arterial blood, while that contained in the corresponding arteries, was of a dark colour. "Hic, sanguinis in adulti arteriis more, viride florebat, ille, venosi sanguinis, nigricabat *."

The blood which passes to the placenta, by the two umbilical arteries, flows back to the body of the fœtus by the umbilical vein, which is involved in a duplicature of peritonæum, behind the recti muscles of the abdomen, to the fossa umbilicalis of the liver, and thence to the left branch of the vena portæ.

A branch of the umbilical vein, called *Ductus venosus*, carries the blood from the left branch of the vena portarum directly into the vena cava inferior.

Thus a part of the blood passes into the vena cava directly from the umbilical vein, without flowing through the liver.

The branches of the umbilical vein are dispersed chiefly through the left lobe of the liver, for very few of them pass into the right lobe.

By the medium of the vena cava, the blood flows to the right auricle of the heart.

The lungs of the fœtus that has not breathed are compact and dense, and, in colour and consistence, bear a strong resemblance to the liver, and readily sink in water: but when the child has breathed, they become much paler and sometimes are variegated; the air-cells are dilated; they almost cover the heart, push downwards the diaphragm, and, owing to the quantity of blood that then flows through the pulmonary bloodvessels, their weight is increased nearly twofold, but their specific gravity is diminished, so that they swim in water.

In order to ascertain whether or not a child has breathed, Plouquet has proposed to take the relative weight of the lungs to the body; but a table, taken from the records of the Hospital of Maternity at Paris, does not confirm his statement.

It may be added, that, by grounding a calculation upon the above mentioned table, it appears, that, during the se-

* Jeffrey, de Placenta.

venth and eighth months of pregnancy, the weight of the lungs, compared with that of the body, is much greater than at the full period.

Besides, it may be added, that after birth the lungs are not expanded all at once, the upper part being first expanded. It is also to be taken into account that the lungs may sink though the child had lived.

A child, according to Wrisberg, may live for seven or eight minutes without breathing.

Dr W. Hunter has stated, " That if a child makes but one gasp, and instantly dies, the lungs will swim in water, as readily as if it had breathed longer, and had then been strangled ;" an observation which has been to a certain degree confirmed by Haller, " that they (the lungs) will swim after a single inspiration ;" but it is necessary to add, that they may sink if the heart be left : hence, in judicial cases, the necessity of cutting away the heart, and making experiments with portions of the lungs.

The lungs may sink in water though the child has breathed, if they be much gorged with blood, or tuberculated, which rarely happens ; and, on the other hand, the lungs may swim in water when artificially inflated, or from containing air, generated by putrefaction.

Such are some of the causes which render it difficult to determine whether or not a child has been born alive *.

It may be proper to add, that, according to Carpuron, the natural causes of death after delivery are,

1*st*, Suffocation, either at the time of delivery, in consequence of the child's mouth falling into the fluid discharges, or after delivery, in consequence of being overlaid.

2*d*, Weakness and fatigue, owing to a long and difficult labour.

3*d*, Fracture or other injuries of the head, occasioned by the child falling on the ground.

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* Those who are desirous of further information on this subject, would do well to read with care a very valuable Review, by my colleague Dr Christison, of the Works of Lecieux, Hutchinson, and Carpuron, on Infanticide, in the 76th number of the Edinburgh Medical and Surgical Journal.

4th, Imperfections, from malconformation, or from simple immaturity.

5th, Obstruction of the nostrils by the membranes, occurring chiefly when the whole conception is on a sudden discharged in a mass.

Soon after birth, the blood generally ceases to flow through the foramen ovale and canalis arteriosus, the umbilical artery and vein.

I have already stated, that, in some instances, those passages by which the blood is diverted from the lungs remain open, which malconformation during life is characterised by peculiar symptoms: these are, however, sometimes absent, owing to the simultaneous contraction of the auricles, and by the two valves of the foramen ovale being pressed together by the auricles, by which the communication between the auricles is almost obliterated.

When the air has entered the lungs at the first inspiration, the air-cells of that organ are considerably expanded, and the blood passes through the pulmonary artery in greater quantity.

Lastly, The child may be destroyed, during labour, from the premature delivery of the umbilical cord, and from continued pressure on it, or from that cord being twisted around the neck, in which case, according to Mr HUTCHINSON, there is a spiral livid mark around the neck *; or it may die from bleeding, from rupture of the cord or separation of the placenta.

* But it may be doubted whether this mark will invariably assume the appearance that has been described. I have frequently examined the appearance of the neck in persons killed by hanging. That part of the skin in the front of the neck, which had been impressed by the rope, has a light-brown transparent aspect, like horn; the veins upon it are much distended with blood of a deep purple colour; and the cuticle is raised here and there. The mark upon the skin ends, on each side, in a narrow point below the ear, and does not extend across the back part of the neck. The thyroid cartilage of the larynx is somewhat flattened.

CHAP. III.

OF SECRETION.

THE term *Gland* has been applied to those organs by which such fluids are separated from the body as are necessary to the varied functions of the animal economy, or are hurtful or useless to it.

The apparatus by which secretion is accomplished is of a more simple or a more complicated nature.

Various fluids, totally different from the blood, are derived from the branches of the arteries called *Exhalant;* these may be called glands of the most simple construction: and other fluids are derived from *follicular organs* or *glands*, which are of a much more complicated construction, being composed of several lobes, united by cellular substance: these have proper bloodvessels, nerves, absorbents, and excretory ducts: these glands are very different from each other in many respects.

Exhalation takes place upon the surface of the body, and also within its cavities, as upon the serous, mucous, and cellular membranes.

The nature of the exhaled fluid is by no means uniform; generally it is of a watery nature; as, for instance, the serous fluid, which is found on the surfaces of the pleuræ, peritonæum, synovial membranes of the joints, and in the cellular membrane. Fat is also probably derived from the exhaling branches of the arteries.

Some glands are single, as the liver and pancreas, others are double, as the kidneys and lacrymal gland; and glands of this description are very various in point of size.

The arteries proper to the different glands are very differ-

ently disposed before entering into the substances of the glands, which has been supposed to have an influence upon the nature of the secreted fluid. The arteries, after having entered the glands, are subdivided into very minute branches, which, in some instances, form continuous canals with the smaller branches of the excretory ducts of these glands; but, in other instances, there are small *cells* interposed between the smaller branches of the arteries, and the smaller branches of the excretory ducts.

Without entering into the merits of the question as to the existence or non-existence of cells in all glands, which gave rise to a warm and long dispute between RUYSCH and BOERHAAVE, I shall state those facts which have fallen under the observation of my Father, who, during the time he was occupied in preparing materials for his Thesis, on the Structure of the Testes, directed his attention in an especial manner to the structure of glands, and made many preparations illustrative of their structure, from which drawings and engravings were at the time taken, two of which * I have thought not unworthy the attention of the reader.

The following is an extract from his Lecture on the Structure of Glands.

"I always conceived, that if there were follicles, many arteries would open into each, but that a single branch of the duct would correspond with each follicle; therefore, I made my experiments, by injecting both, but particularly the ducts; and, in my inaugural dissertation, I have mentioned experiments I had then performed on different glands.

"Since that time, and previous to 1762, I had prepared the chief specimens before you. At first I did not perceive the minute beginnings of the vessels in some of the ducts, but afterwards, on applying better microscopes, I found, that the preparations enabled me to describe the ducts from, or very near to, their first origins.

"We find receptacles or follicles in many glandular parts,

* Plates V. and VI.

varying extremely in their figure. Thus, in the ovaria, we find many spherical bags filled with a pellucid liquor, which we cannot press back into the bloodvessels, nor do we find any duct leading from the bag.

" In like manner, I have found, that the fat universally, whether, what we call marrow, within the bones, or the fat which is under the skin and elsewhere, is deposited into spherical sacs, none of which exceed the $\frac{1}{8}\frac{1}{0}\frac{1}{0}$th or $\frac{1}{8}\frac{1}{0}\frac{1}{0}$th part of an inch in diameter; and although, from the example of the omentum chiefly, there is reason to suppose that the fat exudes, no holes or ducts for its transmission are visible, but it has the appearance of being lodged within such sacs.

" Many spherical sacs, containing mucus, are visible to the naked eye, with a hole in one side of the sac, for discharging the mucus, on the membrane of the nose, the back part of the tongue, the palate in quadrupeds, the pharynx, stomach, intestinal tube, and within the biliary ducts, or within the cervix uteri.

" In other parts, the slime is contained in tubes nearly cylindrical, open at one end. At the root of some of these I have observed one or two conical sacs, opening into the cylinder. Such are found in the urethra of both sexes, and around the mouth of the vagina.

" In the amygdalæ the mucus is contained within irregular shaped large cells, which communicate with each other, and are pierced, on their inner sides, with holes for its discharge, the number of which varies in different persons.

" Within the trachea, the slime is discharged by ducts, visible to the naked eye, which come from glands, which I have observed, not only on the soft back part of the trachea, but disposed in circles between its cartilaginous rings. Small branches, from different parts of these tracheal glands, form each of the ducts, as I have observed with the microscope *.

" I have found, by injections with wax, that very large and minute branches within the prostate gland uniting, form the

* Vid. Plate IV. Fig. 6.

larger ducts from it, which open into the urethra, at the sides of the caput gallinaginis.

" The semen within the testes is contained in ducts which seem to be cylindrical, and are not composed of smaller ducts joining together.

" The sebaceous matter intended for the defence of the surface of the skin from the air and friction, is, in some places, as in the nymphæ or in the face, contained in roundish or long-shaped tubes, open at one end, or is poured out in the axillæ, as I have found, by the ducts of small glands which adhere to the inner side of the skin, where the hairs grow; and different branches within the gland form the duct, or these glands resemble the tracheæ within the cavities of the joints; and within the vesicæ unguinosæ (called by ALBINUS *Bursæ Mucosæ*), no knots or glands are to be found, lodged in crannies of the joints, or protected by the pelotons of fat, such as have been, with much appearance of accuracy, described by authors. We can only observe masses of fat, covered by a vascular membrane, and fringes produced from that membrane; and although it is highly probable that the fimbriæ contain ducts which pour out synovia, yet such are not distinguishable even with the aid of a microscope.

" After carefully examining all the preparations of the mammæ, salivary glands, and pancreas, liver, and kidneys, whether the injection was thrown into the arteries, or into the excretory ducts, I have observed none but cylindrical vessels in the ducts of the mamma; and also, that the globules in the course of the renal artery, were produced by convoluted cylindrical vessels. In the mamma, I found that there were not fewer than 400 *little acini in the breadth of one inch;* and, applying a microscope which magnifies greatly, I could plainly perceive that each of these acini consisted of several cylindrical vessels in its breadth, and of course that the diameters of some of these did not exceed the $\frac{1}{2000}$ or $\frac{1}{4000}$ part of an inch. A similar but less regular structure is observable in the pancreas and salivary glands, and also in the liver *.

* Vide Plate VI.

" Upon injecting, with a penetrating liquor, the venæ portæ, I observed that some part of the injection passed into the hepatic ducts, though I saw no reason to suspect that the vessels were lacerated; and I have often filled the uriniferous tubes from the renal arteries. On the other hand, if I am not much mistaken, I have injected, without laceration, some branches of the vena portarum from the hepatic duct.

" I am, however, certain, that it is more difficult to fill the vena portarum from the duct, than the duct from the vena portarum. Farther, in cases of jaundice, occasioned by biliary calculi, by scirrhus of the head of the pancreas, by thickening and coarction of the common duct, or by putting a ligature around the common duct of living animals, although, in these cases, the person or animal had been jaundiced for many days, weeks, or months, and the hepatic duct, and all its principal branches, were enormously dilated, I did not find that I could press back into the bloodvessels the bile they contained, nor inject a coloured liquor from them into the bloodvessel, more easily than in animals in which there had been no disease of the liver; and, notwithstanding the enlargement of the trunk and branches of the hepatic duct, no follicles giving origin to these were filled by the injection. Hence liquors pass readily from the arteries into cavities, as into the intestines, ventricles of the brain, pericardium, and pleura, but cannot be pressed back into the arteries; and, in all these parts, the openings are probably oblique.

" Upon the whole, it appears to me, that the secerning arteries terminate in four different ways:—

1*st*, There are exhaling branches of the arteries.

2*d*, Many secerning arteries may terminate in one follicle.

3*d*, The beginnings of ducts may probably form continuous tubes with the smaller ramifications of the arteries, as in the kidneys.

4*th*, The secerning branches of the arteries probably terminate obliquely in the sides of the ducts, or perforate their coats obliquely, in the same manner as the ductus communis choledochus passes through the coats of the duodenum. As injections pass more readily from the vena portarum into the

hepatic duct, than from the hepatic duct into the vena portarum, and as, when the common duct has been diminished, the hepatic duct is greatly enlarged; notwithstanding which, injections cannot, without great difficulty, be pushed from it back into the vena portarum; the secreting arteries seem to pass obliquely through the coats of the hepatic duct.

"Hence though the secerning arteries, and also the ducts, seem to be cylindrical, and that the ducts are the continuations of the arteries, I suspect that the arteries pass through the sides of the ducts obliquely.

"From what has been stated, there is reason to conclude, that the structure of the liver, pancreas, mammæ, and testes, is as simple as that of the exhaling terminations of the arteries which secrete the liquors effused into the pleuræ or peritonæum; or that the secretion of the semen from the branches of the spermatic arteries into the cavities of the convoluted ducts of the testicles, seems to be performed by means as simple as, and similar to, the secretion of liquors into the cavities of the stomach and intestines.

"The fluids secreted by the different glands are of very different qualities, and accordingly have been arranged into the watery, oily, &c.

"These fluids are very different from the blood, and do not exist in it; so that the secerning apparatus possess the power not only of separating certain parts of the blood, but also of essentially altering its properties: hence the process of secretion cannot be compared to that of mere straining or transudation of a liquor.

"Many arguments present themselves in support of such an opinion. 1*st*, There is no evidence of transudation taking place in the living body; and the fluids derived from the different glands are very different from the blood.

"2*d*, When a gland, or its duct, is irritated, the nature of the fluid secreted is altered, and the quantity of the secreted fluid is increased, as, during the salivation from mercury, cholera morbus; or, to take the favourite instance of the pleura, if it be admitted that the properties of the serous fluid on the surface of this membrane differ in health and disease, that

remarkable circumstance cannot be explained on the principle of the mere transudation of a liquor.

" By disease, the quantity and qualities of the different secreted fluids are much altered. On some occasions, for instance, the secretion by the skin is very much diminished or suspended; but, on other occasions, it is increased. And, on the other hand, by the disease called Diabetes, the quantity of the urine secreted in 24 hours is sometimes so great as to be equal to 20 lb. or 30 lb., though the patient did not drink more than when he enjoyed good health.

" *3d*, The last argument against the idea of the mere transudation of fluids is derived from the effects of irritation applied to glands. Thus a blow on the female breast occasions the swelling and hardening of the part injured, the vessels of which take on a new action, and secrete the cancerous matter.

" The effects of the venereal or variolous poison upon the vessels of the part to which they are applied, demonstrate the same fact; thus their natural action is so much altered, that they generate the venereal and variolous poisons."

TABLE VI. Fig. 1. Represents the lactiferous ducts of a young woman who died soon after she had suckled her child.

Fig. 2. Represents the lactiferous ducts filled with injection.

TABLE VII. Fig. 1. Represents the ducts of the parotid gland highly injected.

Fig. 2. A Represents the smaller ducts of the inferior maxillary gland highly injected. B The duct of the inferior maxillary gland. C The tongue. D The sublingual gland.

TAB. VI.

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Fig. 3 the same object as Fig. 2 but more magnified.

Fig. 1.

Fig. 3.

Fig. 2.

Tho.s Donaldson del.t

PLATE VII.

CHAP. IV.

OF THE ORGANS OF URINE AND GENERATION.

SECTION I.

OF THE KIDNEYS.

THE kidneys are those organs by which the urine is secreted; thus the balance is preserved between the quantity of liquor we drink, and the quantity of the circulating fluid.

Through these glands that part of the blood which is superfluous is discharged.

The kidneys are situated in the lumbar region behind the peritonæum, on each side of the spine, and lie upon the diaphragm, the larger psoæ, quadrati lumborum, and transversales abdominis muscles, and extend from the eleventh rib nearly to the cristæ of the os ilium.

Owing to the difference between the bulk of the right lobe of the liver and the spleen, the right kidney (supposing the body to be erect) is rather lower than the left. The kidneys are, in a certain degree, retained in their situation by the reflected peritonæum, and by cellular substances. The peritonæum passing from the right kidney to the liver, is said to form the right ligament, and on the left side, the peritonæum extending from the spleen, is said to form the ligament of the left kidney. There are a few instances, (I have seen five of them), in which a transverse portion of a substance, in all respects similar to the rest of the kidneys, connected the lower portions of the kidneys of opposite sides, thereby forming one

kidney, somewhat in form like to a horse's shoe; and with its concavity directed towards the diaphragm. In a few instances there have been three kidneys, and this malconformation did not derange the function of the kidney. The kidneys sometimes are placed in the pelvis. In a specimen preserved in the Museum, both kidneys lay in the pelvis: the right one lay within the true pelvis, and the left was placed at the side of the pelvis; and what was remarkable, both glandulæ renales were in their usual situations, and at a distance from the kidneys. Mr Bryce had occasion to examine the body of a boy, whose right kidney lay in the situation of the caput cæcum coli; and, during life, was supposed to be a tumour or ball in that part of the intestinal canal.

The form of the kidneys is peculiar, and different in different animals, and even in the same animal at different periods of life. Thus the kidney of the bear consists of a congeries of small kidneys; and the kidney of the human fœtus is rounder and shorter than that of the adult, and composed of several lobes. The kidney of the adult is somewhat like an egg, which is a little flattened, with the larger end upwards: both extremities are bent inwards towards the spine, and in length they are generally about five or six inches. The size of the kidney is proportionally greater in children than in the adult; and it consists of lobes, the number of which corresponds with that of the papillæ of the adult.

It sometimes happens, that the kidneys of the adult are lobulated like those of the fœtus. I lately had occasion to see an instance, in which both kidneys of a man afflicted by a disease of the urinary organs, were at least twice as long as in the sound state; both kidneys were lobulated, and the size of these lobules was exactly proportioned to the unnatural size of the kidney. The papillæ of these kidneys had also attained an unnatural size, but preserved their usual conical form.

The kidneys are imbedded in a considerable quantity of fat, which is lodged in loose cellular texture: this has sometimes been called the *Tunica adiposa of the kidney.* The fat around the kidney is of a finer consistence and harder than in other

parts of the body, and is always present even in the most emaciated persons. It is very abundant in granivorous animals, and commonly called Suet.

Each kidney has a smooth, glistening, dense, semi-opaque, purple-coloured capsule, which adheres to the surface of the gland by short cellular threads. This capsule enters the concave part of the kidney, and is fixed to the coats of the blood-vessels.

Upon the coats of the kidney being removed, the substance of the gland presents itself, which is of a red colour inclining to purple; to the touch it is firm and somewhat elastic. In fishes this gland is much paler, softer and more easily torn than in the class Mammalia.

When a kidney has been divided in a longitudinal direction, it appears to be composed of two substances, which differ in colour, texture, and in the arrangement of their constituent parts.

The outer, which, generally speaking, is five or six lines in breadth, is of a red colour, having a great many bloodvessels in its composition, and when a portion of it is pressed between the fingers, several small grains may be perceived. This has been called the *cortical* part, a name not perfectly apposite, as it sends a number of projections into the more interior part of the organ; so that the words *vascular* and *secretory part* of the kidney, are less exceptionable, as conveying a distinct idea of the use of this part of the organ.

The kidney internally is of a pale colour, and is divided into a number of radiated tubes, which converge towards given points; these in their progress become larger, and form between fourteen and eighteen conical-shaped bodies of different lengths, called the *papillæ of the kidney.* Upon the surface of these papillæ, a number of small orifices may be distinguished, through which the urine gradually distils, drop by drop, into the pelvis of the kidney.

By throwing a penetrating injection into the renal artery, the tortuous vessels, composing the greater share of the cortical part of the kidney, are manifest, and the granules or

acini of the kidney are found to be composed of small convoluted bloodvessels *. The tubes which convey the urine from the acini of the kidney, are seen, if the injection has been very penetrating, filled with the injected fluid. There are a few small bloodvessels between the uriniferous tubes. The papillæ of the kidneys have their membranous capsules, or Infundibula, but these are not so numerous as the papillæ, one infundibulum being common to two of the papillæ, in some instances.

The infundibula open into a common cavity, which, in form, is somewhat oval. When distended, it projects behind the kidney, and has been called the *pelvis* of that organ. The pelvis of the kidney has two membranous coats, and from it the Ureter takes its origin.

The pelvis is in part surrounded by the branches of the renal artery and those of the renal vein; hence the great danger of cutting into the pelvis of the kidney, with the view of extracting urinary concretions that are lodged within it.

Setting aside the danger of dividing these large vessels, it may be added, that it might be extremely difficult to extract the urinary concretion, imbedded in the pelvis of the kidney, many of which have branches diverging from the body of it, and which take an exact mould of the infundibula of the kidney.

Each kidney has one large artery which comes off from the abdominal aorta at right angles; and, in some instances, there are two or three such arteries. Owing to the situation of the kidneys, the right renal artery, or arteries, are longer than the left. The smaller branches of the arteries of the kidneys are distributed through every part of the cortical substance of these glands. The larger branches form arches; but there are few communicating branches between these arches, so that an injection thrown into one of the larger branches sometimes fills a part only of the kidney.

The still smaller branches of the renal arteries are distri-

* Vide Plate XXXVI. Fig. 4, 5, 6, in my Outlines of Anatomy.

buted somewhat like to stars, from which many branches pass to the capsules of the kidneys, and others are reflected inwards, and form what have been called the *acini* of the kidneys.

When a penetrating injection has been thrown into the renal artery, it often passes into the uriniferous tubes, or imitates the secretion of urine.

The veins of the kidneys are larger than those of the corresponding arteries; they communicate freely within the cortical substance, and also upon the surfaces of the kidney. These superficial communications, in the seal, are of great size; they ultimately form a large trunk, which opens into the vena cava inferior, and the left vein, the longer, necessarily passes across the aorta.

The nerves of the kidneys are derived from the semi-lunar solar plexus: they form an intimate web, which surrounds the bloodvessels, and enter the kidneys with these.

The absorbents of the kidneys are numerous, and terminate in the lumbar glands.

Of the Renal Glands.

The Renal Glands are of a yellow colour, somewhat of a triangular form, about two inches long, surrounded by cellular substance, and adhere to the upper and fore parts of the kidneys.

These glands are sometimes filled with a bilious looking fluid.

The renal glands of the fœtus are proportionally larger than in the adult, and are nearly as large as the kidneys.

Of the Ureters.

The Ureters are musculo-membranaceous tubes, by which the urine flows from the kidneys to the bladder of urine.

The ureters are situated behind the peritonæum.

The ureters arise from the inner and lower part of the pelvis of the kidney.

These tubes are not cylindrical but contracted, where they

pass over the upper aperture of the pelvis, and where they pass obliquely between the coats of the bladder.

It has been stated, that the whole of the urine does not pass through the ureters into the bladder, but that there are pores or passages, through which it passes directly from the stomach to the bladder. But, considering the difference between what we drink, and the urine, the density of the intervening membranes, the varied situation of the bladder of urine in different animals, such an hypothesis seems very improbable; and it may be fully disproved, by putting ligatures around the ureters, after which no urine passes into the bladder.

The ureters are composed of three coats, viz. of an outer white coat, formed chiefly of condensed cellular substance; of a muscular coat, the fibres of which are disposed in a transverse direction and of an internal mucous coat, which is, like other mucous membranes, perforated by the orifices of a number of small ducts. All of these coats admit of being greatly expanded, and often are so when calculi impacted within them prevent the free passage of the urine into the bladder.

Calculi imbedded within the ureters have sometimes proved a cause of death.

SECTION II.

OF THE URINE, AND OF URINARY CONCRETIONS.

THE Urine is a pale yellow-coloured fluid, which has a slightly bitter taste, and emits, when recently voided, an acid odour, but after being kept, the odour is distinctly alkaline. The urine differs much in its properties at different periods of life, and according to the kind of food, and especially when the digestive organs are weak.

The quantity of urine secreted depends upon the quantity of fluid that is drunk, and very much upon the state of the other secretions, especially upon the quantity of sweat and perspiration. According to BERZELIUS, the following are the ingredients of 1000 parts of urine.

Water,	933.00
Urea,	30.10
Sulphate of potash,	3.71
Sulphate of soda,	3.16
Phosphate of soda,	2.94
Muriate of soda,	4.45
Phosphate of ammonia,	1.65
Muriate of ammonia,	1.50
Free lactic acid,—lactate of ammonia,—animal matter soluble in alcohol, and usually accompanying the lactate,—animal matter insoluble in alcohol,—urea not separable from the preceding,	17.14
Earthy phosphate, with a trace of fluate of lime,	1.00
Uric acid,	1.00
Mucus of the bladder,	0.32
Silex,	0.03
	1000.00 *

In old age, the urine is more highly charged with the earthy phosphates and uric acid; but the urine of a child, where the bones are not completely ossified, contains an excess of benzoic acid, and no phosphoric acid.

Healthy urine contains, also occasionally, other ingredients: very often muriate of potash may be distinguished among the crystals which are formed during its evaporation.

The physical properties of urine are often altered by the nature of the food, or by medicines: rhubarb and turpentine affect the urine much; the former communicates to it a golden colour, the latter gives it the smell of violets.

The proportion of the ingredients of the urine is varied by the quantity of fluid that is drunk, and its chemical composition by the time it is kept; for urine rapidly putrefies, and then contains an excess of ammonia: Also by the nature of the food; thus the uric acid becomes very abundant when little exercise is taken; and, on the other hand, it disappears,

* Berzelius, in Annals of Phil. vol. ii. p. 423.

according to MAJENDIE, from the constant and exclusive use of *unazotised* food, as sugar, butter, gum, oil, &c.

There is every reason to suppose, that a somewhat, hurtful to the animal œconomy, is discharged along with the urine; for the total suppression of this secretion, the removal of the kidneys, or ligatures thrown around the renal arteries, prove fatal in a short space of time.

A partial suppression of urine, which often originates from an obvious cause, as from inflammation of the kidneys, gout, or calculi in the kidneys, is more frequent, and much less dangerous, than the complete suppression. The student should be aware of the difference between the suppression and retention of urine; which latter may be distinguished from the former, by pain and fulness in the region of the bladder, which may be observed to be much distended; and if there be any difficulty in the diagnosis, the fluctuation of the urine may be felt, by introducing the fore-finger of one hand into the rectum, whilst that of the other is applied above the ossa pubis.

By disease, the proportions of the ingredients of the urine are materially altered, and especially by organic derangements of the kidneys and bladder of urine, or by the effect of various irritations applied to these organs, and especially by concretions and other extraneous bodies, lodged within these, or by diseases of the prostate gland.

In that remarkable disorder, called *Diabetes*, the urine, besides being secreted in extraordinary quantity, contains a good deal of sugar, and very little or no urea.

According to Dr HENRY and Mr ROSE, there is no urea in the urine of persons afflicted by the acute chronic hepatitis.

FOURCROY and VAUQUELIN found, in the urine of the jaundiced, a substance, analogous to the yellow acid which is formed by the action of the nitric acid on the muscular fibre.

Though much light be thrown upon the nature and probable consequences of Intermittent and Continued Fevers, of different Dropsies, of the different Exanthemata, of Pneumonia, of Hepatitis, Enteritis, Hysteritis, Peritonitis, Gout, Rheumatism, Hysteria, Rickets, and of Jaundice, by an ac-

curate examination of the state of the urine, yet such an enquiry seems to me to be foreign to the subject of this work, excepting in so far, as that morbid state of tbe urine may give rise to urinary concretions. I refer my reader to Dr Wilson Philip, who, in his valuable Treatise on Indigestion, has pointed out some of the causes by which the secretion of urine is deranged, and to Dr Prout, who has shewn the relations of certain states of the urine, with certain symptoms of disease, in various parts of the animal economy, and also the chemical properties and changes which the urine has undergone, when it has arrived at the bladder; hence his observations are calculated to improve the method of treatment of such diseases.

Gravel, as it has been commonly called, is often mixed with the urine: it may be considered as an index of a disposition to stone, and it occurs either as an impalpable powder, or in regularly *crystallized red particles* of the *uric acid*, or in the form of *brown crystals*, which consist of lithate of ammonia, or lithate of soda, tinged by the colouring principle of the urine, and more or less of the purpurates of ammonia and soda, according to Dr Prout. A deposit of this kind indicates gout, or active inflammatory fever. The *pink sediment*, in the urine, which consists chiefly of lithate of ammonia, indicates the absence of a large proportion of the colouring principle of the urine, and is an index of diseases of the liver, and of hectic fever.

A *white sediment*, composed of *phosphate of lime*, or of the *phosphate of magnesia and ammonia*, occurs in cases of costiveness and flatulence, and derangement of the functions of the alimentary canal. The urine, in these circumstances, is liable to decomposition, contains a white cloud, and becomes alkaline; hence the evolution of ammonia.

When there is a tendency to the formation of the oxalate of lime, there is no deposit in the urine, which is always clear.

Concretions, of considerable size, are not unfrequently found in the uriniferous passages, in persons of all ages. They have been detected in the bladder of urine of the fœtus,

and, according to observation, they are more frequent in the male than in the female, and in graminivorous than in carnivorous animals.

The chemical analysis of urinary concretions is a matter of much moment in a medical point of view, as thus, we become acquainted with the nature of these substances, and may thereby be led to employ those means which are calculated to prevent their increase of bulk, or to dissolve them within the bladder.

Urinary concretions may be divided into six classes. The *first* includes those composed *of uric acid and of urate of ammonia.* The existence of the simple urate of ammonia has been denied by Mr Brande, as, he observes, the ammonia which calculi, composed of the urate of ammonia, contain, arises from the decomposition of the urée, or of the phosphate of ammonia which they contain. The uric acid is more frequently detected in urinary concretions than any other. Of 300 concretions analysed by Dr Pearson, there was scarcely one which did not contain it; and all those analysed by Scheele contained it, of a brown or yellow colour, of a lamellar and radiated texture, and with a smooth surface. Nitric acid produces the red colour characteristic of uric acid. Calculi composed of uric acid are soluble in hot water, and when heated by a blowpipe, give out ammonia.

The concretions of this first class blacken without melting on burning fuel, give out a smell like to that of burning, and afford by by distillation ammonia and prussic acid. They are insoluble in cold water, but are soluble in a solution of pure soda or potash, and from the solution, a precipitate of a fine white powder is thrown down by acids. In many of these calculi, the uric acid is nearly pure, but in others, there is an intermixture of the phosphate of lime, or of phosphate of lime and ammonia.

The *second* class includes such as consist of the *phosphate of lime*, and *the phosphate of ammonia* and magnesia, which are soluble in acids. Those exhibit a laminated structure;

the layers are easily separated, or they are composed of small grains, which are friable, and have little induration, so as to bear a slight resemblance to chalk; but their texture is often not uniform, from being intermixed with uric acid, or phosphate of magnesia and ammonia.

Those composed of phosphate of lime stain the fingers like chalk, are readily broken, are to the taste insipid, and insoluble in water, but entirely soluble in nitric or muriatic acids, from which the earth may be precipitated by ammonia or fixed alkalies.

Calculi of this description are charred by being heated, owing to the animal matter they contain, and do not afford lime, when exposed to a great heat.

Concretions composed chiefly of *phosphate of magnesia and ammonia*, are soft, and generally smooth on the surface, of a brilliant white colour, and consist of lamellar crystals, which assume a prismatic form, are fusible by the blowpipe, and are converted into an opaque white glass: they become black when placed on hot coals, give out an empyreumatic ammoniacal odour, and melt when the heat is raised. There are but few concretions which consist of this triple salt only: it is generally intermixed with phosphate of lime or uric acid, forming alternate layers with these. Such calculi are very soluble in diluted acids, and, when thrown into diluted muriatic acid, the phosphates of lime and magnesia are dissolved, and a membranous substance remains in slight flakes, which consists of albumen. The fixed alkalies disengage the ammonia, also the acid, and separate the magnesia.

The *third* class comprehends such concretions as are soluble neither in acids nor alkalies.

In this class, the *mulberry calculi* are contained; they are externally of a chocolate colour, but internally of a grey or light brown colour, are very hard, and take a fine polish. The prominences on the surface are sometimes rounded, but generally they are pointed and very sharp.

Such concretions seldom or never attain a large size: they consist of lamellæ of unequal thickness. Even when reduced

to powder they are not soluble in alkalies, and scarcely soluble in acids: when burnt, a pure lime, equal to one-third of the concretion, is left, and the oxalic acid is decomposed.

This kind of concretion contains a large proportion of animal matter, to which the peculiar hardness of it is owing.

Dr J. Davy, whilst engaged in examining the urinary concretions in the Museum of this University remarked, that those composed of oxalic acid were not invariably of a dark brown colour.

Some concretions contain *silica*, but it is a very rare ingredient: it was found by Fourcroy in two out of 600 concretions. With the alkalies it fuses and forms glass.

The *fourth* class contains those concretions which are composed of the *muriate of ammonia*. Such concretions, when treated with water, are in part dissolved, and what remains, consists of pure uric acid. The matter dissolved is composed of urea, and partly of muriate of ammonia.

The *fifth* class includes such concretions as are composed of *cyitic oxyde*, a term employed by Dr Wollaston, because hese substances, like an oxide, unite both with acids and alkalies.

Such concretions are white, dense and brittle; do not consist of layers, but are composed of an irregularly crystallised substance, and have a yellow semitransparency. 1*st*, This substance dissolves, and combines with acids and alkalies, and crystallizes with both. It crystallizes with acids, forming slender spiculæ, radiated from the centre, which dissolve readily in water. 2*d*, It is precipitated from nitric acid by alcohol. 3*d*, It does not affect the colour of vegetable blues. 4*th*, It is insoluble in water, alcohol, and ether.

Besides the above substances, urea and animal matter enter into the composition of urinary calculi; the latter of which cements together the other ingredients. In those which consist of uric acid, the animal matter consists of albumen mixed with urea; in those composed of the earthy phosphates, it is composed of albumen and jelly; and in those of the oxalate of lime, of albumen solely.

The *sixth* class contains, those calculi composed of the hydrophosphate of lime, a substance which was first detected as an ingredient in urinary concretions, by Dr JOHN DAVY, who has thus described it. "It is remarkably hard and brittle. On its exterior surface, as the figure exhibits, there is the appearance of a crystalline arrangement in the form of cubes. The calculus consists of concentric coats very slightly adhering together, and very easily detached or broken from each other. The internal layers only differ from the external surface, in being of a lighter colour, and of a less crystalline texture. It is composed of phosphate of lime and water, without any appreciable quantity of animal matter. It possesses the following chemical properties:

"It neither decrepitates nor burns before the blowpipe, but fuses when strongly heated. It readily dissolves, without effervescence, and without affording any sensible residue, in the muriatic and the nitric acids. The whole taken up by these acids, is thrown down by ammonia, and the precipitated matter is quite insoluble in oxalic acid. The calculus, heated to redness in a glass tube, yields as much as 20 per cent. of water, and nothing else besides the fixed phosphate of lime."

FOURCROY and VAUQUELIN have published a summary of the chemical phenomena presented by the re-agents on the ingredients of urinary concretions, which is highly important, as being an index to the nature of the composition of the different concretions.

In addition to the above, a calculus of a reddish brown colour, with a smooth surface, and of a hard and compact texture, has been discovered by Dr MARCET, which he has called the *xanthic oxyd calculus.*

The same author has described also a yellowish brown coloured calculus, like bees-wax in colour and hardness, under the name of *the fibrinous calculus.*

Dr PROUT has also described two new concretions: one is composed of the *lithate of ammonia,* which is of a clay colour, and has a tuberculated surface, and the other is composed of the *carbonate of lime,* which is of a white colour, and of a friable texture.

SECTION III.

OF THE DISSECTION OF THE PERINÆUM OF THE MALE, AND OF THE MUSCLES CONNECTED WITH IT.

The muscles, bloodvessels, nerves, and absorbent vessels of the perinæum, are involved in a considerable quantity of cellular substance and fat: hence much caution and time are requisite in the examination of this very important part of the human frame.

Before beginning the dissection of the perinæum, it is necessary to study the bones of the pelvis, to introduce a staff within the urethra, and to fill the rectum with baked hair, or with a cork, after having washed out its contents.

The body of the subject is to be placed with the lower extremities bent, and the knees drawn upwards, as when the surgeon is about to perform the lateral operation of lithotomy, whilst an assistant raises and holds up the scrotum. The common integuments are to be divided from the anterior verge of the anus to the root of the scrotum, by which a fascia of a tendinous nature is exposed.

In some subjects, there is so much fat under the skin, that when it has been divided, as in performing the lateral operation for lithotomy, the opposite sides fall together, and prevent the surgeon from seeing the deeper parts.

On removing the skin over the perinæum, a strong tendinous fascia comes into view, which is fixed to the ossa ischia and pubis, and also, to the tendinous aponeurosis of the muscles of the thigh, and which is loosely connected with the cellular substance of the scrotum.

This fascia prevents the escape of matter found here, and also the effusion of urine, when the urethra has been ruptured: hence, when the urine has escaped, and has formed a swelling in the perinæum, the urine passes upwards to the scrotum, which being of a loose texture, yields before the

effused fluid, occasioning a considerable swelling, which at length bursts.

The progress of the disease may, in many cases, be arrested, by making an incision in the perinæum.

The muscles attached to the perinæum are *the sphyncter ani*, *the transversalis perinæi*, *the levator ani*, *accelerator urinæ*, *erector penis*, and *the coccygeus muscles*. The first is a single muscle, the other five are in pairs.

The dissection of these muscles is to be conducted in the following manner:

A semicircular cut is to be made on each side of the anus, which should meet at the posterior part of it, from which an incision is to be continued to the extremity of the ossa coccygis. This dissection is to be continued, carrying the knife sometimes backwards and sometimes forwards, so as to expose one-half of the cutaneous sphyncter ani, and the acceleratores urinæ.

One-half of the cutaneous sphyncter is to be raised from the fat as far as the verge of the anus. This loose half of the sphyncter is to be held firmly towards the other half of the internal sphyncter, till it be cleaned by raising the fat.

From the posterior extremity of the accelerator urinæ, an incision is to be made transversely, so as to expose the transversalis perinæi, and a part of the levator ani.

An incision is to be made at the side of the os ischium, to expose the crus penis covered by its erector muscle.

The acceleratores urinæ are exposed, by dividing the skin over the raphe; and, in order to show the levator ani, it is required to remove a good deal of fat which covers it, and afterwards to dissect its origins from the inner side of the pelvis.

Of the Sphyncter Ani.

The extremity of the rectum is surrounded by an oval-shaped muscle, which is placed immediately under the skin, and has been called, on account of its office, *sphyncter ani*.

The fibres of this muscle are parallel to each other, and, at the anterior perinæum, are closely connected with those of the

accelerator urinæ, and behind, with the skin and fat, and also with the extremity of the ossa coccygis, by means of a ligamentous membrane.

Upon removing this muscle, circular muscular fibres come into view, which have been described by WINSLOW and some other anatomists, as an internal sphyncter; but these are merely the circular muscular fibres of the intestinum rectum.

This muscle may be ranked among the semivoluntary muscles, that is, it contracts so as to close the anus and retain the fæces, without our being conscious of it, and that contraction is independent of the will; but at pleasure, by means of the muscles of the abdomen, we can overcome the resistance of this muscle.

This muscle is often thrown into an inordinate state of contraction by the irritation of piles; and when this happens the patient suffers acute pain in the pile, which still more increases the contraction of the sphyncter muscle, and the pain.

As the extremity of the rectum is encircled and contracted by the sphyncter ani, extraneous bodies that have been swallowed, or calculi formed within the intestines, often have stuck within the rectum, and have proved a cause of much uneasiness. *

The antagonists of this muscle are the longitudinal fibres of the rectum, and the abdominal muscles.

There is a sort of balance between the action of the longitudinal muscular fibres of the rectum and the sphyncter ani, so that when that balance is destroyed a prolapse of the rectum follows: hence, owing to repeated and violent straining at stool, or to the relaxation of the sphyncter muscle, often the concomitant of infancy and old age,—of the too long continued use of emollient clysters,—of long continued diarrhœa or dysentery, a prolapsus ani sometimes takes place.

So great is often the relaxation in weakly children, that a prolapse takes place without pain or violent exertion, every time they go to stool: the prolapse may be readily returned,

* Vide Morbid Anatomy of the Stomach, Gullet, &c.

but it is difficult to cure the disorder until the system be strengthened.

A prolapsus ani is also occasioned by the irritable state of the rectum, or of the neighbouring parts; as from stone within the bladder, cancer of the womb or of the vagina,—from such irritation as not only increases the natural action of that bowel, but occasions strong contraction of the diaphragm and abdominal muscles, which produces the inversion of the rectum more readily than of any other part of the intestine, as, by its being fixed, it cannot elude the effect of the pressure.

In some instances the mucous membrane of the rectum only has been protruded; it becomes swollen, and, owing to the pressure on the veins, a watery fluid is effused between the coats of the protruded bowel, which adds much to its bulk. As the prolapsed portion of the intestine is not supported by the contiguous parts, it continually becomes longer, and, at length, by the sphyncter ani which encircles it, a strangulation ensues; and owing to the pressure preventing the flow of blood to the prolapsed portion of intestine, an inflammation comes on, which is succeeded by gangrene.

This is the most unfavourable termination of the complaint. When this disorder has been neglected, and when the mucous lining of the rectum has been for some time exposed to the air, like other mucous membranes in similar situations, it loses its natural sensibility, becomes harder, and not unlike to the skin, so that it creates no uneasiness, excepting what arises from the bulk of the swelling.

Of the Transversalis Perinæi.

This muscle is placed in the posterior part of the perinæum, and towards the middle of the space between the anus and bulb of the urethra, and is always covered by a good deal of fat, even in persons who are rather emaciated.

This muscle is not constant as to the precise place of its origin: it arises by a tendon, and sometimes by fleshy fibres, from the fatty substance that covers the ascending branch of

the tuber ischii, in some instances before, and in others behind the origin of the erector penis.

There is considerable variety as to the size of this muscle of some individuals, in the opposite sides of the body. It sometimes arises rather farther back than usual, and follows an oblique course to its insertion in the anterior part of the sphyncter ani, about half an inch behind its junction with the accelerator urinæ.

In these circumstances, the fibres of this muscle are oblique, but transverse when the muscle takes its rise nearer to the symphysis pubis. In some instances, there is on each side a smaller and narrower transversalis perinæi, which is disposed in a parallel manner to the preceding muscle, and which, when present, is called the transversalis perinæi alter.

The use of this muscle is, to draw backwards and sideways the urethra, and to enlarge the bulb of that canal.

In some instances no transversalis perinæi is to be found.

Of the Levator Ani.

The levator ani is a thin broad sheet of muscular substance, which closes the lower part of the pelvis, supposing the body to be erect, and may be said to be the antagonist muscle to the diaphragm.

To obtain a satisfactory view of the extent and precise situation of this muscle, it is required to remove one of the ossa pubis, so as to get a lateral view of the pelvis; thus, the outer surface of this muscle is in contact with the obturator internus, the transversalis perinæi and glutæus maximus muscles, and the inner surface is in contact with the prostate gland, rectum, and bladder of urine.

The relation of this muscle to the rectum, prostate gland, and vesiculæ seminales, is most distinctly seen, upon the thin fascia which covers it having been removed.

This muscle arises from the lower and inner part of the symphysis pubis, by tendinous and fleshy fibres, from the spine of the ischium, and from the thin tendinous membrane which covers the obturator internus and coccygeus muscles,

and descends from a circumference, as it were, towards a centre, to its insertion in the intestinum rectum.

The posterior parts of the levatores ani, of opposite sides, unite and pass behind the rectum, and the larger fibres of the muscles are fixed into the ossa coccygis, including the rectum. The anterior portions of these muscles pass down before the rectum.

The levatores ani form a sort of inverted funnel, the narrow end of which is undermost, and the portions fixed to the os coccygeus, together form a sort of tape or swath about the intestinum rectum. This is also attached by its extremities to the sides of the pelvis, and the bulb of the urethra. The levatores ani, besides surrounding the rectum, include the lower part of the rectum, the vesiculæ seminales and prostate gland, and in women also the vagina.

The anterior fibres of this muscle, which are disposed somewhat like the sticks of a fan, descend, and cover the membranous part of the urethra, and are fixed below to the anterior part of the sphyncter ani: those which take their rise from the inner part of the symphysis pubis, descend obliquely forwards, and are somewhat elevated by the prostate gland, which they cover, and a portion of the muscle is fixed to the triangular ligament of the urethra.

The levatores ani and coccygei muscles form the lower part of the abdomen, support the hollow bowels included within the abdomen and pelvis, during the violent action of the diaphragm, as in coughing and sneezing, as may be felt by putting the palm of the hand on the perinæum. By means of the diaphragm and levatores ani, the perpendicular diameter of the abdomen is enlarged or contracted.

The most remarkable degree of contraction takes place in the effort of expelling hardened fæces; and, on the other hand, the abdomen is enlarged to the greatest degree, during violent expiration, as in sneezing or coughing, and it is to be taken into account, that the diaphragm has a more powerful effect than the levatores ani and coccygei muscles.

The levatores ani, besides elevating the rectum, may have

an effect in expelling the contents of the vesiculæ seminales, and prostate gland, and thereby assist in generation.

The levator ani, together with the sphyncter ani, prevent the prolapsus ani; the former draws up the anus, and the other is contracted around the extremity of the anus. But when the inner membrane of the rectum has been much irritated by ascarides within that bowel, or by a stone in the bladder, the levator ani and sphyncter ani do not oppose the prolapse of the villous coat of the rectum. Mr A. Burns favoured me with the history of a case of hernia of the bladder of urine, which took place through the levator ani muscle *.

Of the Erector Penis or Ischio-Cavernosus.

This muscle, and its flat tendon, cover very nearly the whole of the crus penis that is in contact with the os ischium. It takes its origin from the inner surface of the tuberosity of the ischium, by fibres, some of which are fleshy, and others are tendinous. The fibres adhere to the inner side of the ascending branch of the ischium; pass upwards and forwards, (supposing the body placed as when the lateral operation of lithotomy is performed), along the crus; and the muscle terminates in a flat tendon, which is inserted into the ligamentous membrane of the corpora cavernosa, where the corpora cavernosa are united to each other.

The erectores muscles are supposed, by compressing the crura penis, to be essential to the erection of the penis, by forcing the blood onwards towards the fore parts of the corpora cavernosa penis. When the penis is erected, these muscles tend to draw the crura penis downwards and towards the tubera ischii; so that it forms nearly a right angle with the body. The erection of the penis is to be imputed, in part, to the pressure upon the veins of the penis impeding the return of blood from that organ; and, in part, to the increased determination of blood to the cells of the penis, in consequence of the nerves of that organ being stimulated.

* Vide my Morbid Anatomy of the Gullet, Stomach, and Intestines.

Of the Levator Urethræ of Mr Wilson.

In some cases, there is so intimate an intermixture of the fibres of this muscle, and those of the levator ani, that it is very difficult to separate them. In others, there is a distinct layer of fat or cellular substance between these; and the fibres of the levator ani are large, and collected into fasciculi, whilst those of the levator urethræ are very small, similar in point of size, and intimately united to each other, like the muscular fibres of the substance of the heart. A few scattered fibres descend from the symphysis pubis, and pass around and suspend, as it were, the membranous part of the urethra; and, on other occasions, the fibres of this muscle are disposed from the symphysis pubis somewhat like the spokes of a fan. Some of these pass backwards, others downwards, and others pass forwards.

Of the Bulbo-Urethrales or *Acceleratores Urinæ.*

This penniform muscle covers the bulb of the urethra, and about three inches of the corpus spongiosum urethræ. In the centre of the muscle, a white line may be distinctly perceived; this is the tendon, from which the muscular fibres proceed in somewhat different directions: those in the fore part of the muscle are most oblique, whereas those which cover the bulb are nearly transverse, and those in the middle are neither so oblique as those in the front, nor do they follow so transverse a direction as those of the posterior part of the muscle.

The thin tendinous origins of this muscle from the ascending ramus of the ischium, and descending ramus of the pubes, are covered and concealed by the crura penis.

The posterior fibres of this muscle are intimately interwoven with the fibres of the sphyncter ani, and those of the transversalis perinæi.

By this muscle the urethra is compressed, and its contents are expelled. The acceleratores urinæ also assist the sphyncter vesicæ in retaining the urine within the bladder, by closing the bulb of the urethra, when the call to pass it is very

urgent. This muscle also contributes to the erection of the glans penis; by its pressure on the corpus cavernosum of the urethra, the blood is forced into the glans penis.

After having removed the muscles of the perinæum, the bulb of the urethra comes into view: it is in form somewhat like to a cone, projects backwards, and is very near to the intestinum rectum. The bulb is, in part, covered by means of the triangular ligament of the bladder.

Of the Compressor Prostatæ of Albinus.

Anatomical authors differ very widely in their descriptions of this muscle. This muscle has been particularly described by Santorini and also by Albinus, in his Historia Musculorum.

SECTION IV.

OF THE BLADDER OF URINE.

The bladder is a musculo-membranous sac, situated in the pelvis, immediately behind the ossa pubis, which receives and contains, for a certain time, the urine.

The size and figure of the bladder vary at different periods of life, and in the different sexes.

The capacity of the bladder does not bear a ratio to the age of the individual; it is proportionally larger in an infant, and rises much higher above the ossa pubis; and may more readily be cut into, above the ossa pubis, without opening the cavity of the abdomen. The upper aperture of the pelvis of the fœtus is so small that the rectum, distended by the meconium, almost fills the whole pelvis. When a child is three or four years old, the pelvis has generally attained such a size as to admit the bladder.

At the period of birth, the bladder, in form, is like to a pear, the broader part of which is uppermost: the neck of the bladder may be compared to the narrower end of the pear, and its length is nearly three times greater than the transverse diameter.

There are some instances, according to HALLER, in which the bladder of the adult rises nearly as much above the ossa pubis, as that of an infant.

The bladder of the adult, when moderately distended, is in shape like an egg, with the larger extremity undermost: it is somewhat flattened in front, and also behind: its uppermost part is directed upwards and forwards, and the lower part downwards and backwards; and the distance from the upper to the under part of this organ, is greater than from side to side.

By disease, the form of the bladder is materially altered; thus from the irritation of a stone, it is sometimes contracted in its middle, like a sand-glass, or divided, in its under part, into two lateral portions.

The breadth of the bladder is not the same in both sexes; that of the female is rounder and broader than that of the male; and, from continued distention, acquires a larger size. According to CELSUS, the bladder sometimes inclines to one side, owing to the peritonæum being attached obliquely to the bladder.

The bladder of a woman who has had several children is generally larger than that of a virgin, owing to the enlarged womb having impeded the free exit of the urine. The bladder is sometimes much contracted, as happens in persons who have suffered a violent death; or from an extraneous body having been lodged within it, its coats are much thickened, and its capacity is diminished. Hence, before attempting the operation of lithotomy, it is of the greatest moment to ascertain whether the bladder will rise above the ossa pubis. Thus we learn whether the coats of the bladder be in their sound and distensible state or not.

For the sake of more accurate description, anatomists describe the *Fundus*, or upper part of the bladder, the body and the neck of that organ. The bladder is retained in its place, 1*st*, By the peritonæum, which is reflected from the recti and pyramidales muscles of the abdomen, and which covers the upper posterior part of the bladder, and also a portion of the sides of it. 2*d*, By the impervious *umbilical arteries* and

the *urachus*, which are placed between the peritonæum and abdominal muscles, it is connected with the navel. The two shrivelled umbilical arteries pass obliquely from the sides of the bladder, and the urachus ascends between these, from the fundus of the bladder. The urachus of the adult is about the size of a small writing-quill, fibrous, of a white colour, and extends from the fundus of the bladder to the navel, where it is lost, becoming insensibly of a very small size.

It is generally solid, but sometimes hollow; and it has been said by LITTRE, that the urine sometimes passes through it, and escapes at the navel, which happens only when the neck of the bladder has been obstructed.

According to HALLER and BOYER, the urachus is hollow; and the latter author found twelve small calculi, of the size of millet-seeds, within it. The urachus of the quadruped is also hollow, and passes along the chord to the sac called *Allantois*.

3d, The bladder is retained in its place by the tendinous aponeurosis, which is derived from the obturator internus muscle. This fascia extends from the sacro-iliac symphysis to the symphysis pubis, and is connected with the linea ilio-pectinea. This fascia is reflected off from the obturator internus muscle upon the sides of the bladder. It is thicker where it covers the obturator internus muscle than where it covers the sides of the bladder; and, as it ascends upon the bladder, it becomes gradually thinner. This fascia covers the prostate gland and vesiculæ seminales; forms the septum between the pelvis and the perineum, and is gradually lost on the body of the bladder, where it is uncovered by the peritonæum. This fascia is divided into two layers, one of which is reflected upwards, to cover the sides and fore part of the bladder, which, at its fore part, forms the anterior ligament, and is continuous with the back part of the triangular ligament of the urethra: it includes the prostate gland, to which it gives a firm covering, and also the vesiculæ seminales, and is lost between the bladder and rectum. The other layer of this fascia, which is very thin, includes the rectum. This fascia forms what may be called the Anterior Ligament of

the bladder, which is not unlike to the falciform ligament of the liver, in point of form. Between the layers of this anterior ligament, there are distinct muscular fibres.

The base of this anterior ligament is towards the neck of the bladder. It then covers the prostate gland; is connected, by its apex, with the under and inner part of the symphysis pubis, and is continued forwards, to be fixed to the posterior part of the triangular ligament of the urethra. On each side of the anterior ligament, there is a thimble-like cavity, capable of admitting the point of the little finger, through which the veins which return the blood from the penis pass.

4th, The peritonæum, reflected from each side of the bladder, forms the lateral ligaments of that bowel.

Of the Bladder of the Adult Male, when distended.

In order to form an accurate opinion of the figure of the bladder, it is necessary to fix the attention, first, upon its anterior, and then upon its posterior, and, lastly, upon its lateral portions.

Upon the bladder being distended, that part of the body of it which lies upon the rectum, in the first place, changes its figure; the fundus ascends towards the umbilicus; the bladder almost fills the cavity of the pelvis; the anterior part of it presses upon the ossa pubis; the lateral portions are rounded, and the posterior presses upon the rectum.

In consequence of farther distention, the bladder ascends above the ossa pubis, inclining forwards over these bones. The inferior part of the bladder becomes broader; so that the distance from side to side is greater than from the fore to the back part: it also extends backwards, pushing the rectum before it, and the smaller intestines upwards and backwards.

If the rectum be filled by fæces, that impedes the distention of the bladder to a certain degree.

During the time the bladder is distended, the surgeon should particularly notice the situation of the orifice of the urethra, which does not take its rise from the lowest part of

the bladder, but about the breadth of a finger and a half above it in the male, and somewhat lower in the female; and therefore a urinary concretion is more readily discharged, along with the stream of urine, from the female bladder. As there is a portion of the bladder behind, and placed lower than the orifice of the urethra, small concretions may probably lodge within this portion, and may not be tangible by the sound, unless the patient be examined in different positions.

When the healthy bladder has been fully distended, a space equal to two or three inches intervenes between the ossa pubis and the fundus of the bladder. In some instances, the bladder rises much higher, and fills a considerable share of the belly. I had occasion to visit a man whose bladder was so large that 12 lb. of urine were repeatedly drawn off from it; and Mr HUNTER has stated, that the bladder of one of his patients filled so great a portion of the abdomen, as led him, at first examination, to suppose his patient afflicted by dropsy of the belly. As the bladder, when distended, rises so much above the ossa pubis, it may be punctured or cut into above the ossa pubis; and the instrument, if passed obliquely downwards, will be less apt to wound the opposite side of the bladder.

As the under and back part of the bladder is much extended, when it becomes necessary to puncture the bladder, on account of a retention of urine, the bladder may also be punctured from the rectum; but it may be difficult to distinguish the triangular space between the vesiculæ seminales, on account of the thickening of the bladder; or to distinguish, by the touch, the vesiculæ, which are rendered flat by the pressure of the over-distended bladder.

When the bladder is much contracted, the figure of the bladder is somewhat rounded, and it is situated lower down in the pelvis.

In the contracted state of the bladder, the peritonæum is loose between the bladder and rectum; and, in this state of the bladder, the rectum forms a considerable projection inwards upon the bladder. In women, this is more obvious, as the vagina adds to the bulk.

When the bladder is empty, it falls into folds, which are disposed irregularly; for the inner coat possesses little contractility. In that state, it is difficult to grasp the stone which may be lodged within it; and, on the other hand, the coats may be injured by the forceps.

Dr CAMPER has justly observed, "Peritonæum aliquando laxe hærit inter basin seu verum fundum vesicæ, ac intestinum rectum, contractione abdominis magis deorsum inter vesicam et rectum compellitur; unde contingere potest, ut sectione imprudenter facta peritonæum ledatur, vel forcipe prehendatur, lacereturque." And, besides, if the operation shall be performed when the bladder is empty, there is much risk of wounding its coats, in two or three different places, when the gorget or knife is introduced.

The internal surface of the bladder is smooth when that organ is distended, and besmeared by mucus, the source of which is not evident, even when, from the irritation of a stone, or other disease of the bladder, an extraordinary quantity of mucus is secreted: hence it seems probable, that the mucus is secreted by the arteries, and distributed upon the inner surface of the bladder.

The lower part of the inner surface of the bladder has been called *Trigone*. It is rather whiter than the rest of the bladder, and bounded before by the urethra, and laterally by the openings of the ureters. Mr LIEUTAUD affirms * that he discovered this projection; but, according to GIRARDI †, the publisher of SANTORINI's 17 engravings, that distinguished anatomist discovered what LIEUTAUD has called the *Trigone of the Bladder*.

The neck of the bladder possesses a considerable degree of extensibility, especially if the extension be made slowly; hence urinary concretions, of a very considerable size, have

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* Vide Histoire et Mem. de l'Acad. Roy. des Scien. Paris, 1753; and his Essais Anat. Paris, 1753.

† Vide his Explanation of Plate XV., which is well worthy of the perusal of the reader, as containing some excellent remarks on the diseased state of the Trigone.

been discharged from the bladder of the female, by gradually dilating the urethra and neck of the bladder.

The lowest part of the bladder is a depression between the base of the *trigone*, and the posterior part of that organ, in which small particles of sand, or urinary concretions, are very often imbedded.

The neck is the most sensible part of the bladder: the moment the point of a bougie touches it, the patient has a desire to void his urine, though there be little or no urine at the time in the bladder. Owing to the same cause, patients afflicted by stone in the bladder experience acute pain when they get out of bed, from the stone falling down upon the neck of the bladder.

Over that part of the bladder called by LIEUTAUD, *Trigone*, in the recent body, we always observe the inner membrane of the bladder of a pale red colour, owing to the number of small vessels which are distributed upon that part of the mucous membrane.

Of Diverticula from the Bladder of Urine.

The more usual form of the bladder has been already described. In a few instances, there are processes or diverticula connected with it, which are similar in appearance and structure to those which grow from the intestines.

These diverticula are connected with different parts of the bladder, and have been more particularly noticed by HALLER *, and also by PALETTA †.

A representation is given, in my Morbid Anatomy of the Stomach and Intestines, of an instance of a hernia of the bladder, in which there existed such a diverticulum from the bladder of urine.

Of Deficiency or Malconformation of the Bladder.

There are instances in which the bladder has been entirely wanting, and in which the ureters terminated in the intestinum rectum or in the vagina.

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* Opera Pathol. Obs. 44.

† Exercit. Pathol, (p. 153.) De Vesicæ Diverticulis. Mediol. 1820.

The anterior part of the bladder is also, on some occasions, deficient; so that the posterior part of it has formed a tumour above the ossa pubis. I have seen three instances of such malconformation. In the hypogastric region there was a red rounded tumour, of an irregular form, the surface of which was constantly kept moist by a fluid which was discharged upon its surface from two orifices, the orifices of the ureters, into which a probe might be passed to the depth of several inches. Beneath the tumour, there was a sort of penis, about an inch long, which was grooved on its upper surface, and which terminated in the glans, which was covered by a prepuce. One of the individuals had attained his 40th year, and was in the habit of exhibiting himself. He had testes of the usual figure and size. His case has been particularly described by Professor Bonn, and Doctor Baillie has described a similar case.

Of the Coats of the Bladder of Urine.

The bladder is a musculo-membranaceous receptacle of urine, consisting of four coats of different structure; the external coat derived from the peritoneum, which gives but a partial covering to the bladder,—a muscular coat,—a cellular coat,—and an internal mucous lining.

The peritonæum, which is reflected from the pubis, or, in the distended state, from the parietes of the abdomen, covers only the upper and back part of the bladder of the adult, and only a small portion of the front and upper part of the bladder of the fœtus. It is reflected from the bladder to the fore part of the rectum of the male, and the uterus of the female; and, as it passes from the bladder, there are folds at the sides of that organ, which have been called by some anatomists, the Posterior Ligaments of the Bladder.

It is of much moment that the surgeon should possess a distinct idea as to the place the peritonæum is reflected off from the parietes of the abdomen, and from the bladder to the rectum of the male.

It may be remarked, that there is great variety as to the

place where the peritonæum is reflected off from the bladder of urine, in different individuals.

The external surface of this coat is besmeared by a quantity of a serous fluid.

Its internal surface adheres to the muscular coat, by means of very loose cellular membranes, and adipose matter.

The peritoneal coat is similar to the peritonæum of other parts of the body; it possesses a great share of elasticity, thereby adapting itself to the different states of extension of the bladder, and being constantly besmeared by a serous fluid, it always presents a smooth surface to the viscera of the abdomen. The peritoneal coat of the bladder is sometimes the seat of acute inflammation.

This cellular membrane has not the same thickness, or even appearance in every part of the bladder. In the anterior and lateral regions, the cellular substance is lax, and there is a considerable quantity of fat intermixed with it. It has been described by some authors as a distinct coat.

Around the vesiculæ seminales we find a dense cellular substance, of a whiter colour. The cellular substance has been stated to add considerably to the strength of the bladder; for, when it is dissected off, the internal coat is protruded betwixt the muscular fibres.

The *Muscular Fibres* of the bladder, in the healthy state, are flattened, of a pale colour, of a small size, and disposed in fasciculi, which cross each other in every possible direction, and completely surround the bladder.

When the bladder is distended, and the muscular fasciculi are elongated, these fibres are much separated from each other; so that the internal coat of the bladder is seen between them; but, when the bladder is empty, the muscular fasciculi of that organ approximate each other. These muscular fibres are not of an uniform size. Those which are external are the largest, and are disposed in a longitudinal direction. The smaller cross these.

I conceived it to be matter of great moment to trace, with care, the direction of the fibres of the bladder, and especially that of those fibres which are disposed around the neck of

that organ, concerning the course and existence of which, very different accounts have been published by different anatomists.

With the aid of my assistant, I have examined the course of these fibres, in several instances; and, to render my description more intelligible, have subjoined engravings * from drawings which were taken, with very great care, from nature, by a very skilful artist, Mr Macinnes.

Of the Muscular Fibres of the Male Bladder.

The muscular fibres of the bladder arise from the prostate gland, and from two small muscles, which proceed from the ligaments of the prostate to the fore-part of the neck of the bladder. These fibres are composed of an inner and an outer stratum, which pass imperceptibly into each other.

The fibres of the fore-part of the bladder are smaller than those of the sides. The fibres of the sides are flat, particularly those which follow a transverse direction and form the inner stratum. Most of the fibres of the outer stratum are disposed longitudinally; others, however, run in a serpentine course, describing portions of larger and smaller circles.

The fibres of the upper part of the bladder are paler than those of the lower portion and neck; the superior fibres, resembling, in colour, those of the stomach; the inferior, those of the œsophagus.

The muscular fibres of the anterior side of the bladder arise from the prostate gland, and from two small muscles of a triangular shape, extending from the ligaments connecting the prostate gland to the under and inner part of the symphysis pubis. These triangular muscles are thin, of a deep red colour, and, on the inside, separated about an inch from each other. They are covered by the ligaments of the prostate, from the outer and under parts of which ligaments they take their origin. Like these ligaments, they are insulated, having on their outside the little depressions of the ilio-vesical fascia; and, on their inside, the membrane of the infundi-

* Tab. VIII, and IX.

bulum, or digital cavity. They are separated at the fore-part by a large plexus of veins, and by the cribriform fascia, which divides them from the muscles described by WILSON. Their inferior surface faces towards the prostate gland, where there is interposed between the gland and the muscles, a plexus of veins, formed by the branches into which the vena dorsalis penis divides on passing through the cribriform fascia. Each muscle is divided by a few veins, into two portions, the superior and inferior; the superior deriving its origin from the upper part of the prostatic ligament, close to its connection with the symphysis pubis; the inferior, arising from the lower end of the ligament, contiguous to its attachment to the prostate. The superior fibres of this muscle of the right side pass backwards to the fore-part of the neck of the bladder, and, about an inch behind the prostate gland, cross over the corresponding fibres of the left side, spreading out on the lateral and fore-parts of the bladder. The inferior and largest portion of this muscle extends almost directly backwards, in the form of a triangle, the base of which is attached to the neck of the bladder, where it is intimately connected to its fellow. From this base, after being connected to its fellow by a few cross slips of fibres, it radiates in several directions. The most internal fibres run almost parallel to each other, and, with the fibres of the opposite muscle, proceed along the fore-part of the bladder, over other fibres, originating from the prostate. Some of these parallel fibres reach as far as the base of the urachus, into which a few are inserted. The most exterior fibres embrace the neck of the bladder, and mingle with those of the back part, where a few assist in forming the transverse fibres of the inner stratum.

Below, and a little to the outside of, this muscle, some scattered fibres, described by SANTORINI, appear, which arise from the fore and lateral parts of the prostate, encircling the bladder with numerous fibres, running chiefly anterior to the entrance of the ureters.

Between these muscles of SANTORINI, and a fasciculus at the back-part of the bladder (afterwards to be described), there are a number of fibres, extending from the posterior and

lateral surfaces of the prostate, which, spreading out on the lower part of the bladder, form the very strong fibres that are laid over the bladder at the point where it is perforated by the ureter. Some very minute fibres of this portion are reflected upwards and backwards on the ureter, and seem to compose its longitudinal muscles.

A fasciculus of fibres, the largest and most prominent on the outside of the bladder, arises from the posterior of the prostate, at the point of its attachment to the seminal vesicles. This bundle proceeds backwards and upwards, in a longitudinal direction, increasing a little in breadth as it ascends to the middle of the bladder, where it divides itself into three portions, the two lateral and central.

From the middle of the bladder, the lateral portions commence, diverging forwards and upwards, in a curvilineal form, to the anterior of the bladder, whence they are seen passing downwards, in a circular direction, nearly as far as its neck.

The central portion extends upwards, to a point situated about three inches from the urachus. Around this point they describe numerous circles on the summit and posterior part of the bladder, the most anterior fibres of which come in contact with the back of the base of the urachus.

On detaching the highly elastic mucous membrane from the inner stratum, we find, that it firmly adheres to the muscular fibres by bloodvessels, and a cellular tissue, which is short, compact, and remarkably white. The mucous coat dips into the depressions between the muscular fibres. Towards the neck of the bladder the membrane becomes gradually thinner and more transparent, adhering very closely at the trigone.

The muscular fibres of the inside of the bladder follow chiefly a transverse course, and they form distinct fasciculi at the back-part of the bladder, of a considerable breadth, being very much separated from one another; resembling, in this respect, the pectinated muscles of the right auricle of the heart. These larger columns are connected by numerous slips of fibres, so that they appear to intersect each other at different angles. By this intersection of the

muscular fibres, various depressions are formed, giving to the inside of the bladder an irregular reticulated appearance. About two inches above and behind the openings of the ureters, the largest fibres run in a transverse direction, and between them are observed very distinct oval-shaped fissures. Towards the lateral and fore part of the bladder they become smaller and pass more obliquely. Near the attachment of the urachus, the transverse and oblique fibres gradually diminish in size, converging to its base, on which they are lost.

A set of extremely fine fibres, of a yellowish colour, is placed on the trigone, proceeding from different directions, but chiefly from behind, forwards to its sides; they, at its margin, suddenly assume a small size, resembling, in fineness and minuteness of texture, the muscles described by Wilson. A very prominent set of the fibres proceeds, almost transversely, between the openings of the ureters. The rest of these fibres surround the under part of the neck of the bladder in numerous concentric layers, terminating at each side of the fore-part of the neck; from this they pass backwards in a curvilinear form, and are convex towards the centre of the trigone.

On the superior part of the neck of the bladder another set of fibres, redder and larger than those described, is observed, disposed in a circular, but opposite direction, around the upper part of the neck of the bladder, which are covered by the under set of concentric fibres. The exterior fibres diverge considerably towards the sides of the bladder, whereas the interior, after closely embracing the neck of it, are lost in the under concentric fibres, with which they are intimately intermixed.

SECTION V.

OF THE PENIS.

The penis is an organ which is intended to conduct the semen into the uterus and vagina of the female: it is placed in

front of the symphysis pubis, to which it is fixed by a ligament, called *Ligamentum Suspensorium*, a reflection of the serous membrane which includes the corpora cavernosa. The length of the penis, when erected, is equal to that of the vagina. The length and breadth of the penis are by no means uniform in all individuals of the same stature, but vary in different individuals, and still more in different nations. Generally speaking, the penis is larger in the Negro than in the European.

At birth, the penis is remarkably small, and the glans penis is covered by an elongated prepuce, which renders the penis pointed at its extremity: the opening into the urethra is very small, and sometimes so much so, as to prevent the free discharge of the urine.

About the age of 13 or 14, there is a rapid increase in the size of the organs of generation of both sexes.

There are also many well attested cases of premature puberty; and in which children, between 4 and 5 years of age, have had emissions of semen, and the testes, scrotum, and penis as large as those of an adult.

Too early venereal excitement has a striking effect in enlarging the female breast. BLUMENBACH * has observed: "Contraria cura ambitum mammarum augeri posse nullum dubium est: quantum vero præterea Venus quoque præmatura eo conferre possit memorabile sane exemplo impuberes et nondum adultæ puellæ docent."

The penis is so constructed, that it may be occasionally distended, elongated, and erected. In its undistended state, it is cylindrical; but, when distended, rather of a triangular shape. It is composed of two bodies, called *Corpora Cavernosa*, and of the urethra, which are included within skin, cellular substance, and a serous membrane.

Anatomists generally speak of two corpora cavernosa; but, as the partition between them is imperfect, and readily admits any fluid to pass from the one to the other, it may perhaps be

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* Vide Med. Chir. Trans. of London, vol. xii. part i. p. 81.

† De Gen. Human, Var. Nativ. § iii.

more correct to describe only one corpus cavernosum. This forms by much the greater share of the penis: upon its upper surface, it has a groove upon it, which lodges the vena or venæ ipsius penis, and the corresponding nerves and lymphatic vessels; and, upon its under surface, there is a much larger groove for the urethra.

The penis is covered by a loose and thin skin, which has upon it a number of sebaceous follicles, and is joined to the membrane of the corpora cavernosa penis by long bands of cellular substance.

At the anterior extremity of the penis, a fold or *Præputium* is produced by it, which is fixed behind the glans penis; and the under part of the prepuce is attached to the glans, by a process called *Frænum.*

Some boys at birth have the prepuce of an unusual length and tightness, so that the glans penis cannot be uncovered: they are then said to have *Phymosis.* To some this proves a source of no inconvenience, and about, or soon after puberty, when the glans and corpora cavernosa penis have attained a greater bulk and length, it is removed by frequent erections of the penis: but to others, the constriction of the prepuce is a great annoyance; it gives rise to an anasarcous swelling of the prepuce, which adds to the constriction, and prevents the free discharge of the sebaceous fluid secreted by the glands at the root of the glans penis: this, by being accumulated, becomes acrid, thereby proving a cause of much uneasiness, and sometimes of inflammation or ulceration of the prepuce; or retention of urine, originating from a similar cause, sometimes has led to the formation of urinary concretions under the prepuce.

There are other causes of inflammation of the prepuce, as gonorrhœa virulenta, chancres, warts, or excoriation of the glans. This inflammation sometimes gives rise to the accretion of the glans and prepuce, or the ulceration of the glans.

In a few rare instances, there is no opening in the prepuce: at birth the urine fills it, forming a tumour, which in a few hours attains so great a size, that it conceals the penis and scrotum.

We also sometimes meet with boys who have pushed the prepuce so far back, that it cannot be pushed forward again, and this occasions much pain, swelling and inflammation, which sometimes is followed by gangrene; this state is called *Paraphymosis.*

Sometimes at the period of birth the prepuce is split, or it is too short, or awanting, or the prepuce has been destroyed by ulceration and sloughing.

Paraphymosis is most frequent from the thickened prepuce being, during coition, forced backwards behind the glans, and not being brought forwards, in which circumstances, the constricted prepuce acts as a tight ligature.

The membrane of the corpora cavernosa penis is of a pale grey colour, elastic, thick, firm, strong, and distensible; not easily divided by the knife; evidently fibrous, and the greater number of these fibres are disposed in a longitudinal direction.

This membrane is not of an uniform thickness; it is rather thinner at the anterior extremities of the crura penis, and where it lines the groove for the urethra, than elsewhere.

This membrane is closely connected with the periosteum of the ossa ischia.

The corpora cavernosa penis, which are to the touch soft and loose in the undistended state, are placed side by side as far as the symphysis pubis, and united laterally two thirds of their whole length.

Behind the symphysis pubis they diverge somewhat like the strokes of the letter V, and terminate in two small rounded bodies, each of which forms a cul de sac, and is united by ligamentous fibres to the ascending branch of the os ischium.

The anterior extremity of each corpus cavernosum is a blind sac, which is received into a concavity at the base of the glans penis, to which they are firmly fixed by cellular substance and a few bloodvessels.

But the corpora cavernosa penis and glans penis do not communicate, for even air does not pass from the one to the other.

Nearly opposite to the vena ipsius penis, we meet with an imperfect partition between the corpora cavernosa, which divides the penis longitudinally: it consists of a number of strong ligamentous cords, which are not in immediate contact; for there are spaces between them, through which any fluid passes readily from the one corpus cavernosum to the other.

The corpora cavernosa when distended are rounded laterally, and flattened in their upper and under surfaces; they are not of an uniform diameter, but are rather smaller at each extremity than in the middle.

I have lately examined, with considerable attention, the structure of the corpora cavernosa penis of man, and of the horse, and also that of the human spleen, and am disposed to think the structure of these organs similar. They consist of a congeries of arteries and veins, which form continuous canals, without the intervention of any cells.

The best description given by any author, of the structure of the corpora cavernosa penis, occurs in the works of Vesalius: he has observed, "Corpora hæc (cavernosa) enata ad eum fere modum, ac si ex innumeris arteriarum venarumque fasciculis quam tenuissimis, simulque proxime implicatis, retia quædam efformarentur orbiculatim a nervea illa membraneaque substantia comprehensa *."

Of the Glans Penis.

The glans penis, which forms the extremity of the penis, is somewhat like a cone in figure, the basis of which is surrounded by a prominent margin; and at the apex, the orifice of the urethra is placed.

The glans is covered by the prepuce, which defends it from being injured by friction. The prepuce is fixed to the glans by the frænum, which is lodged in a groove in the under surface of the glans, which extends to the orifice of the urethra.

The use of the frænum is to prevent the prepuce from being drawn too much backwards; but if the frænum be too short,

* De Corpor. Human. fab. lib. v. cap. xiv.

it may prevent the complete denudation of the glans penis, and it is liable to be torn during coition.

On each side of the frænum there is a small projection: these projections have been called *Colliculi glandis.*

The surface of the glans, when the penis is undistended, is of a pale red colour, and somewhat corrugated; but that of the distended penis is red, rounded, and to the naked eye smooth.

The inner membrane of the prepuce is reflected over the glans penis, and is united with the mucous membrane which lines the urethra.

This covering is, to the touch, smooth and soft: it is composed of a very thin cuticle, and of a soft true skin, with a number of villi upon it, which are very conspicuous after the bloodvessels of the penis have been filled successfully with wax.

These villi consist chiefly of bloodvessels, and on account of the extreme sensibility of the glans, it is probable (for it has not been demonstrated) that nerves enter into their composition.

In my Outlines of Anatomy, I have stated, that the glans penis is made up chiefly of a plexus of small convoluted veins, which communicate with the corpus spongiosum urethræ.

Since the publication of these Outlines, Moresci of Milan has published a commentary *De Urethræ corporis glandisque structura.* He has described, with great minuteness, the course of the veins which compose the corpus spongiosum of the urethra, and which cover and form the glans penis.

He has described the veins of the glans as being of different sizes; but in the preparations preserved in the Museum of this University, the veins which enter into the structure of the parietes of the urethra, and those on the surface of the glans penis, are nearly of the same size; indeed more so than any other veins of the body: they follow a very convoluted course; after having injected the large vein or veins on the dorsum of the penis, he found veins also passing from it on the inner side of the prepuce, which form arches, which become smaller as they approach its extremity. Some of the branches run behind the glans penis, giving branches to the

sides of the prepuce, and describe convolutions on the sides of the frænum, where they are lost.

The glans penis is besmeared by a white unctuous fluid of a very peculiar smell, which is said to be sebaceous. This fluid is derived from a number of small, hard, grey-coloured bodies, called *Glandulæ odoriferæ*, situated around the corona glandis. These glands are not equally conspicuous in all individuals: in some persons, two or three rows of them may be observed, after the cuticle has been removed *.

In warm climates the fluid secreted by these glands is more abundant than in more temperate climates. This has led to the practice of circumcision, by which the glans penis is readily washed, and the accumulation of the sebaceous fluid, which in warm climates becomes by accumulation very acrid, is prevented.

After circumcision the cuticular lining of the glans becomes thicker, and it has been said that the sensibility of the glans is not diminished.

The corpora cavernosa penis are supplied with blood by branches of the pudic artery.

It has been already stated, that the glans penis and corpus spongiosum urethræ consist of a plexus of small convoluted veins.

The veins of the penis are united into a large vein or veins, called Vena or Venæ ipsius Penis, which is situated in the middle of the upper surface of that organ. This large vein passes through the triangular ligament of the urethra, and under the symphysis pubis, and pours its blood into a number of large veins, which form a plexus upon the side of the bladder, and which are placed under the inferior ligament of the bladder, which that organ receives from the tendinous aponeurosis of the obturator internus muscle. These veins ultimately terminate in the trunk of a large vein, which accompanies the posterior iliac artery.

The veins that cover the prostate gland, follow a tortuous course, and unite with the veinous sinuses of the bladder of urine.

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* Morgagni in his *Adversaria* has particularly described these glands.

The small veins of the extremity of the rectum follow a tortuous course, and unite with the vein that accompanies the pudendal artery; and some of them pass into the veins which accompany the sacral lateral arteries, which veins join with the venous sinuses of the lumbar vertebræ.

The penis is largely supplied with nerves, the larger trunks of which are situated upon the upper surface of that organ, and are accompanied by many lymphatic vessels, which run into the uppermost cluster of inguinal glands.

SECTION VI.

OF THE URETHRA.

The urethra, the canal common to the urine and semen, extends from the bladder to the extremity of the penis, being, at an average, about nine inches long in the adult, but sometimes it scarcely exceeds eight inches, and, at other times, it is very near ten inches in length.

In the strictest acceptation of the words, the urethra is not a canal, for, excepting whilst the urine and semen are passing through it, its opposite sides are in contact with each other. In some instances the urethra does not pass through the glans penis, but opens behind it, or in the perinæum.

The urethra describes a tortuous course.

Much pains have been taken by anatomists and surgeons to ascertain the precise course and diameter of different parts of the urethra, by filling it with melted wax, or by passing through it wax or leaden probes, and adapting these to its curvatures; but the object in view has not been obtained; of which the very different forms given to the bougie, by different surgeons, and to metallic sounds, are sufficient evidence.

For examining the bladder of a patient, supposed to be afflicted with stone, sounds of different lengths and shapes are required: they must be varied according to the position of the stone; some must be much bent, to reach the higher parts of the bladder; others should be more nearly straight, to touch

a stone imbedded behind the prostate gland. For sounding the bladder, a catheter, made of steel, as recommended by my Father, is a good instrument; for when the bladder is empty, the stone may then be discovered.

To me it seems probable, that the exact form and size of the urethra cannot be ascertained, considering the materials of which it is composed; for that part of the urethra which passes through the triangular ligament does not change its place, whereas the other portions are connected with the flexible elastic corpora cavernosa penis; beside, the membrane of the urethra is very elastic, and also the corpus spongiosum urethræ, which incloses it, and is, at the same time, compressible.

The above circumstances are sufficient to show the difficulty, nay impossibility, of arriving at a knowledge of the precise course or capacity of different parts of the urethra; beside, the course of the urethra is different in the distended and in the collapsed state of the penis.

The course of the urethra pubis is altered by different positions of the body; and hence the very great superiority of a flexible silver or gum catheter, which adapts itself to the curvatures of the urethra, in whatever situation the body is placed.

The urethra takes its rise from the bladder, near to the lowest part of that organ; and, after emerging from the prostate gland, passes through a circular aperture in the triangular ligament of the bladder, and then descends and passes forwards, for about half an inch.

This ligament fills the upper part of the space, which intervenes between the rami of the ossa pubis, and its broader edge, which forms a portion of a large circle, with its concavity downwards, or towards the anus: it may readily be felt, like a stretched cord, immediately under the bulb of the urethra.

The triangular ligament is covered by a plexus of small veins, by the bulb of the urethra, by Cowper's glands, by the acceleratores urinæ, and by skin.

This ligament, in some bodies, has somewhat of a fleshy appearance.

This ligament serves as a bond of union between the ossa pubis; and it on many occasions, proves a barrier to the ready introduction of an instrument into the bladder, and to the withdrawing the forceps, in extracting a stone from the bladder of urine, in the horizontal direction.

Beyond the symphysis pubis, the urethra ascends between the crura penis, and fills the groove between the under surfaces of the corpora cavernosa penis, where it is lodged, included within its corpus spongiosum, and at length passes through the glans penis, and terminates in a vertical aperture, the edges of which are of a red colour.

In short, that part of the urethra which is before the symphysis pubis, forms an arch with the other and deeper portion of the urethra, the concavity of which is towards the symphysis pubis, or it is convex towards the perinæum.

The urethra of an infant is rather more bent in its course than that of the adult; as the bladder is placed higher up in the pelvis, and, according to some authors, constitutes one of the bowels of the abdomen.

The urethra is not of an uniform diameter in its whole course. The portion included within the prostate gland is somewhat like a funnel, the broader end of which is next to the bladder of urine. That part of the urethra called the *Membranous part*, is considerably narrower, and nearly cylindrical.

The urethra is then expanded into an oblong sac, for about two inches, where it passes through the bulb of the urethra; and from that it is nearly of an uniform diameter, to the root of the glans penis, where it is again expanded into an oblong sac, which has been called by some anatomists, the *Fossa navicularis*, and, at its extremity, it is again contracted.

The narrowest part of the urethra is at the place where the membranous part of it joins the bulb.

On account of the irregular diameter of the urethra, it is sometimes difficult to pass the bougie beyond the bulb; besides, the inferior part of it is out of the direct course of the urethra; it is considerably under it, so that if the instrument be straight, and pushed forwards in a straight line, the point

of it would pass out at the perinæum; hence the importance of depressing the handle of the instrument, so as to raise the point of it, in order that it may pass through the membranous part of the urethra into the bladder.

On account, also, of the small size of the urethra, at that part of it which is behind the bulb, and the sudden turn it describes, upwards at the same place, the point of the instrument may be arrested in its progress; to which the unyielding sides of the triangular ligament very much contribute; and I strongly suspect, that the unyielding edges of the triangular ligament have often been mistaken for a stricture of this part of the urethra, and the more especially, as the extremity of the bougie is indented, (which is supposed to be the most marked symptom of stricture of the urethra), in consequence of having been pitched against the triangular ligament of the urethra.

By introducing the finger into the anus, so as to elevate the point of the instrument, it may usually be passed into the neck of the bladder of urine, provided the penis shall be, at the same time, drawn forwards upon the catheter, which has the effect of stretching it.

Stones are frequently impacted within the urethra; and they most frequently stick in the narrowest part of that canal.

The irritation of the calculus creates inflammation, and still farther contraction, to which spasm essentially contributes; and when the calculus is fixed in its place by mere spasm from the muscular structure, it is relieved by anodynes, fomentation and bleeding.

Where the urethra passes through the prostate gland, it has merely a mucous membrane lining: it is fixed to the substance of that gland, by a dense cellular substance.

That part of the urethra which is beyond the prostate gland, has usually been called the *Membranous portion* of the urethra, because it has not the same degree of support as the other portions of the same canal.

But it is not entirely membranous, as is implied by the name; for it is immediately surrounded by muscular fibres, which the late Mr Wilson of London has described, as pass-

ing downwards from the symphysis pubis, and as joining under this portion of the urethra. These muscular fibres, by their contraction upon the semen, during its course through the urethra, may prevent it from being driven backwards, by the contraction of the acceleratores urinæ; and as Mr Wilson has stated, by pressing the membranous part of the urethra against the symphysis pubis, may materially diminish the caliber of the canal of the urethra.

The contraction of these muscles may also impede the passage of an instrument into the bladder.

The membranous portion of the urethra is covered by a part of the levator ani, and it is also inclosed within a plexus of veins, which were discovered, and have been particularly described by Mr Wilson of London *.

The rest of the urethra is included within what has been called a *Spongy substance*, which has been supposed, by some anatomists, to be of a cellular structure, but which evidently consists of a plexus of small veins which describe a tortuous course.

The bulk of this corpus spongiosum depends upon the quantity of blood which it contains; and in the Negro, in whom all the parts are larger than in the European, I have observed, that, after the veins of the corpus spongiosum urethræ have been filled by injection, the bulb of the urethra fills almost the whole of the space between the ossa pubis, so that it would be impossible to perform the lateral operation of lithotomy, without cutting the bulb of the urethra.

During the erection of the penis, the corpus spongiosum urethræ is distended like to the corpora cavernosa penis. The smaller tortuous veins of the corpus spongiosum may be readily filled from the large vein of the dorsum of the penis.

This spongy substance, which is covered by the same cellular sheath as the corpora cavernosa penis, begins in the form of a conical-shaped process, the apex of which passes obliquely downwards, in the direction of the perinæum, between the crura penis; it is covered below, and at its sides, by the

* Vide p. 152. of his work on the Urinary and Genital Organs.

accelerator urinæ; and it is connected to the arch of the pubis by a strong triangular-shaped ligament. The corpus spongiosum gradually becomes narrower, and terminates at the fore-part of the penis, being expanded, so as to form what has been called the *Glans penis.*

The corpus spongiosum urethræ is covered by the acceleratores muscles; and when the very sensible glans penis is stimulated, these muscles are roused into action; they contract; and in consequence of their attachment to the other muscles of the perinæum, they are fixed by the other muscles, and thus the semen is pushed rapidly along the urethra.

The acceleratores urinæ being oblique muscles, tend, like the other oblique muscles, as those of the pharynx, not merely to contract upon the contents of the part they surround, but also completely to close the canal of the urethra, and thereby prevent the regurgitation of the semen.

Upon cutting the corpus spongiosum urethræ transversely, it may be observed to be, in some cases, divided by a transverse septum; a circumstance which has generally been overlooked by anatomists.

Of the Mucous Membrane that lines the Urethra.

The membrane of the urethra is a mucous membrane, and continuous with that of the bladder of urine, and so thin as to be semi-transparent; the colour of a staff, passed through it, being quite obvious.

When the orifice of the urethra is examined in a living person, the red colour of the mucous membrane lining that canal may be distinctly seen for about an inch from the extremity of the penis, but in other parts it is of a pale red colour; and after a successful injection, or when inflamed, as in gonorrhœa, it assumes a red colour, from the number of vessels which are proper to it.

In the collapsed state of the penis this membrane is gathered into a number of folds, which are disposed in a longitudinal direction, but which disappear when it is extended.

There has been much difference of opinion, as to the muscular structure of the membrane of the urethra.

My Father, Mr J. Huntrr, and Sir E. Home, hold that the urethra is truly a muscular organ.

These muscular fibres are quite conspicuous, in some cases, to the naked eye, as in a preparation which has been for twenty years in the Museum of this University; and, in this preparation, the disposition of these fibres accords entirely with the elaborate drawings by Mr Bauer, of the longitudinal muscular fibres of the urethra, published in the Philosophical Transactions of London.

Many circumstances induce me to believe the urethra muscular.

1*st*, The muscular structure of the urethra, is in some cases obvious to our senses.

2*d*, The stream of urine being smaller, during the cold weather of winter, than during the warm and relaxing weather of summer; and when the membrane is inflamed, in consequence of the irritation of the urine, it contracts so much, as to prevent the urine being discharged in a full stream; it then comes away drop by drop; but after immersion of the penis in tepid water, the urethra is relaxed, and the urine discharged in a full stream.

3*d*, The sudden and temporary obstruction to the flow of urine which sometimes happens to persons with slight stricture of the urethra, on going from a warm room into the cold air.

4*th*, The obstruction which is opposed to the entrance of a stimulating injection into the urethra, or of instruments, which last are sometimes forced out from the urethra. Another very strong argument in favour of the muscular structure of the urethra is, the very great facility with which a catheter is passed through the urethra into the bladder of urine, in cases of paralysis, when the muscular fibres of the urethra, owing to their paralytic state, are incapable of opposing resistance to the entrance of the instrument.

5*th*, The obstruction being removed by large doses of the tinctura muriatis ferri or of laudanum, and other antispasmodic remedies.

6*th*, The combination of the permanent and spasmodic strictures, which latter comes on suddenly, is occasional,

and frequently so great as to prove a complete impediment to the discharge of urine, and yet may often be removed by the exhibition of narcotic remedies.

7th, The very striking analogy in the symptoms of the spasmodic stricture of the urethra, and in those of the spasmodic stricture of the gullet, in which canal the muscular structure is quite obvious.

8th, The contraction of the accelerator urinæ, and other muscles within which the urethra is included, is not sufficient to account for the phenomena of the spasmodic stricture: thus a bougie may often be passed down to a stricture without opposition; but upon being applied to the stricture, the urethra contracts upon the instrument, and firmly grasps it. If the instrument had been grasped by the muscles which are external to the membrane of the urethra, it would glide readily along the part uncovered by muscles, but would be firmly grasped by that part included within the muscles, which does not happen, the instrument being generally and firmly grasped by the membrane of the urethra.

The internal surface of the urethra has been described as being smooth; and it appears so to the naked eye; but when examined by a magnifying glass, numberless small papillæ come into view, which are the orifices of glands.

The internal surface of the urethra is lubricated, and defended from the acrimony of the urine, by mucus, which is derived from a number of orifices, capable of admitting a hog's bristle, which are seen only in that part of the urethra which is before the membranous part. The number of these orifices is very considerable, and varies much in different individuals; 50 or 60 of these may generally be enumerated.

The mouths of these orifices are directed forwards, and on tracing them, they are found to lead to canals about a quarter of an inch long, which are lined by the continuation of the mucous membrane lining the urethra.

Mr Bauer has beautifully represented *, the glands from

* Vide Philos. Trans. of London for 1820.

which this mucus is derived, which may be expressed from the orifices of these glands.

In consequence of inflammation and other diseases, this mucus which besmears the surface of the urethra, is not only altered materially in its qualities, but also increased in quantity.

These mucous orifices are not uniform as to size: there is frequently a large orifice or lacuna on the upper surface of the urethra about an inch from its extremity; it is an oblong slit, and large enough to admit the point of a small bougie.

There are also sometimes two other orifices near to the bulb of the urethra, viz. the Ducts of Cowper's Glands. These merit the attention of the surgeon, as the point of his catheter may get into them instead of passing on to the bladder of urine: this however, may be prevented by depressing the handle of the instrument, which has the effect of elevating the point of it; and upon this being done, the instrument readily passes into the bladder. The foramen cæcum placed at the beginning of the caput gallinaginis may also receive the point of a bougie, which gives great uneasiness to the patient, even when the urethra is not in a very irritable state, but especially when it is enlarged, as in cases of stricture. This also may be avoided by raising the point of the instrument.

When a considerable part of the urine has been drawn off, the bladder collapses, and falling upon the extremity of the catheter impedes the flow of urine through it,—a circumstance which has led Camper to propose, that an opening should be made in the catheter at some distance from its extremity, so that all the urine contained within the bladder might be discharged: hence also the utility of employing a longer catheter than usual, and with holes so large, that clotted blood or very viscid mucus contained within that organ, (which generally happens in the organic derangements of the coats of the bladder, and in cases of stone), may readily pass through it.

As the urethra is lined by a thin membrane, which is apt to fall into folds, it follows that the more nearly the size of the bougie or the catheter corresponds with that of the urethra, the more readily it may be passed through it. By such

an instrument the urethra is sufficiently dilated; and in the case of the operation of lithotomy, when this instrument is of the full size, the groove in the staff is more easily distinguished, especially if the groove be made in the side of the instrument.

In passing these instruments, whilst with the one hand the instrument is pushed forwards, with the other the penis should be drawn as it were upon the instrument.

The membrane of the urethra being in itself very irritable, and surrounded by irritable muscles, which by their contraction mechanically oppose the passage of an instrument through the urethra, it follows, that when a metallic instrument is to be passed, it should be previously immersed in warm water, or kept for some time in contact with the body of a living person.

The act of passing an instrument along the very irritable mucous lining of the urethra, creates at first the most disagreeable sensations, and on some occasions fainting; but after an instrument has been repeatedly passed, this membrane, like others of a similar description, loses much of its sensibility.

Much attention should be paid to the posture of the patient during the passing a bougie, catheter or sound, into the bladder.

The shoulders should be elevated, the knees drawn upwards, and the feet supported on a chair, in order to throw all the parts into a state of relaxation.

The bulb of the urethra being out of the direct course of the urethra, it sometimes happens that the catheter is stopped at that part of the urethra; which may generally be got the better of, by making the instrument to pass as it were along the surface of the pubes.

As the membrane of the urethra is very elastic, it may be considerably enlarged so as to admit stones of the size of a pea to pass through it. The neck of the bladder also admits of dilatation.

This practice, according to Prosper Alpinus, was followed

in Egypt *. The urethra of the male was inflated. A wooden pipe, eight fingers long, the smaller end of a conical shape, was passed into the urethra; the operator blew into it with force, pressing at the same time on the perinæum, to prevent the air from getting into the bladder; and the mouth of the pipe was then stopped. An assistant passed two fingers into the anus, and forced the stone into the urethra.

The pipe was then suddenly removed from the urethra, and thus stones as large as olives were extracted.

The dilating the urethra, was also practised by HILDANUS, and Dr MOLINEUX, so far back as the year 1692. Vide Phil. Trans. vol. xvii. Vide also a paper by Dr YELLOLY in Medico-Chir. Trans. vol. vi.

This practice, as appears from Professor WALTHER's catalogue of his Anatomical Museum, was common in Prussia, and was attended with success; and of late it has been intrcduced into this country by Mr THOMAS and Sir ASTLEY COOPER. The latter gentleman extracted, from the bladder of a man, a stone which weighed 54 grains, by artificially dilating the urethra by a bougie †.

Sir ASTLEY COOPER has observed, "When a great number of calculi are found in the bladder, the circumstance is generally attended with an enlargement of the prostate gland, and it depends upon a sacculus being formed in the bladder directly behind the enlarged gland. In these cases the bladder is rarely completely emptied of its contents, and the calculi crystallize from the urine retained in this sac.

"Such stones do not in general acquire the magnitude of those formed under the usual circumstances, and, from their number and collision against each other, their surfaces are generally smooth, and their shape is commonly rounded.

"When calculi are thus placed, they are so concealed in the bag in which they are contained, that, in sounding, the instrument is liable to pass over them without their being discovered; and it is therefore necessary to dip the sound to-

* Vide his book de Medicina Ægypt. Venice, 1591.

† Med. Chir. Trans. of London, vol. xii, p. 337.

wards the rectum as it enters the bladder, in order to detect them, or to pass the finger into that intestine, to raise them from the bed in which they are concealed; and it is for want of attention to this circumstance that I have known a person pronounced not to have the stone, from whom I afterwards removed thirty-seven by the operation of lithotomy."

The instrument, which Sir ASTLEY COOPER made use of, for dilating the urethra, was in the shape of a sound, consisting of two blades, that acted like a pair of forceps in clasping the stones.

" His patient was placed across his bed, with his feet resting on the floor; a silver catheter was then introduced, and the bladder emptied of its urine. I then (says Sir ASTLEY) passed the forceps into the bladder, and was so fortunate in my first operation as to extract eight calculi.

" The instrument gave but little pain on its introduction; but when opened to its greatest extent, and the stones admitted between its blades, their removal was painful, more especially at the glans penis, which appears to be the portion of the urethra which furnishes the greatest resistance to the removal of the stones.

" A dose of opium was given after each operation, which was repeated seven times before the calculi were all removed."

Sir ASTLEY adds, " Farther experience is required to determine if it be best to dilate the meatus in a few minutes or hours, or in several days by more gradual dilatation *."

In a late case, treated by Mr HAMILTON, though the female urethra was so much dilated as to admit to pass through it a stone of an ounce weight, which had been lodged within the bladder, yet no degree of incontinence of urine followed. —It may be added, that the operation occupied no less than eighteen hours, and was attended by very acute pain.

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* Vide Medico-Chir. Trans. of London, vol. xii. part I. p. 239.

SECTION VII.

OF THE MALE ORGANS OF GENERATION, AND THEIR APPENDAGES.

THE testes of the adult are contained in a purse or bag, called *Scrotum*, which externally is formed of the common integuments, internally of a bed of a reticulated cellular substance of considerable extent, and which is continuous with the skin of the penis and thigh; so that, in cases of anasarca, the scrotum attains a large size, owing to the accumulation of water within it, in which there are in some robust men muscular fibres, which have been described as a muscle under the name *Dartos*.

The skin of the scrotum is of a brownish purple hue: has in young persons a rugose surface in cold weather, but during warm weather it is soft and relaxed, so that the testes appear to hang loose and low.

There is a prominent ridge upon the scrotum, called *Raphe*, which is opposite to the partition which divides the scrotum into two distinct sacs.

The scrotum is covered by a few hairs, and is largely supplied by sebaceous glands.

There is very little or no fat within the scrotum, excepting near to the under abdominal aperture.

The skin of the scrotum is largely supplied with nerves, which are derived from the external pudic nerves, and it is very sensible.

The bloodvessels of the scrotum are derived from the pudendal and femoral vessels.

SECTION VIII.

OF THE TESTES.

BEFORE describing the testes, it seems necessary to premise a description of the spermatic chord, by the medium of which

the testes are connected with the body, and along which the artery from which the semen is chiefly derived, and the accompanying veins and nerves, pass.

Of the Spermatic Chord.

The Spermatic Chord may, for the sake of more accurate description, be divided into an external and internal part.

The external part, which descends obliquely from the under abdominal aperture, to the body of the testis, consists of the spermatic artery and spermatic veins, of absorbents, nerves, and of the vas deferens, which are united by a cellular substance; it is covered by a superficial fascia, by the cremaster muscle, and by a process of the peritonæum, which may be called the tunica vaginalis of the spermatic chord, and which, in hernia of considerable duration, has sometimes attained a considerable thickness.

That part of the chord which is internal is much smaller than the external portion. It is composed of the spermatic and epigastric artery, the former of which takes its rise from the fore-part of the aorta, generally below the renal; it crosses over the ureter and psoas muscle, becoming gradually larger, and passes into the pelvis behind the peritonæum, and under the edge of the internal oblique and transverse muscles; when it reaches the under abdominal aperture, it covers the origin of the epigastric artery: it then passes along the spermatic chord, to which it gives several small branches; and on reaching the body of the testicle it divides into several small branches, which are distributed through the body of that gland.

This, in proportion to its diameter, is the longest artery of the human body, and in quadrupeds describes a tortuous course, and is much longer than in man; it seems, therefore, probable, that this very peculiar mode of distribution of this artery is essential to the secretion of the semen.

A branch from the epigastric artery very frequently accompanies the vas deferens in its course along the spermatic chord.

The veins which correspond with the spermatic artery are larger than it; they unite and form a plexus of a pyramidal shape, which plexus, in its progress upwards, passes along the surface of the psoas muscle: from the plexus there is a single trunk which, on the right side, terminates in the vena cava, and, on the left, in the renal vein.

The lymphatic vessels of the testicles are large and numerous.

The nerves of the testicles are derived from the renal plexus and from the lumbar plexus of nerves.

In the back-part of the spermatic chord we also meet with a tube, which, when pressed between the fingers, feels like a portion of whip-cord; this is the excretory duct of the testicle, called the *Vas Deferens*, which is detached from the spermatic chord, opposite to the upper abdominal aperture in its progress to the vesicula seminalis.

The muscle called *Cremaster* also constitutes a considerable share of the spermatic chord. It takes its rise from the internal oblique muscle of the abdomen, near to the junction of the os ilium and os pubis; it descends along the spermatic chord, and divides into a number of thin muscular fibres, which are fixed into the vaginal coat of the testicle.

The bowels, in a case of hernia at the groin, generally slip downwards along the spermatic chord, and in front of it; but sometimes they somehow or other insinuate themselves between the constituent parts of the chord, so that the vas deferens lies in front of the hernial tumour, where it may be materially injured in opening the hernial sac *.

Of the Testes of the Adult.

The Testes are generally situated in the scrotum, but sometimes they remain within the abdomen throughout life.

The testes, which are of an oval form, and somewhat flattened laterally, are placed obliquely, with one end upwards and forwards, and the other downwards and backwards.

The left testicle is somewhat lower than the right.

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* Vide my Morbid Anatomy of the Gullet, Stomach, and Intestines.

There are generally two testes only, but sometimes there are three.

The testes, at the period of puberty, are larger than in old age.

The testes are protected from external injury by a continuation of the peritonæum, which forms what has been called the *Tunica Vaginalis Testis*, is connected with the cremaster muscle and the inner surface of the scrotum by loose cellular substance.

The tunica vaginalis is, upon inflation, found to be more capacious than the body of the testicle; it includes the body of the testicle and epidydimis, and its surface is besmeared by a serous fluid. This coat being reflected, forms a white coat, commonly called *Tunica albuginea*, which adheres intimately to the body of the testicle, and, though very smooth externally, is found to be internally very unequal on its surface.

The body of the testicle is divided into two parts; into the larger anterior and rounded part, called *body*, and into an oblong process, or posterior part, called *Epidydimis*, both of which are covered by the tunica albuginea; which is the bond of union between these parts, and also serves to conduct their bloodvessels.

The body of the testis is of a pulpy yellowish substance, and consists of a series of very small tubes, which are intersected by small ligamentous chords passing from one side of the tunica albuginea to the other.

The minute elastic convoluted tubes of the testicle may be separated from each other by a fine needle, or by steeping the testicle in water, whereby it is converted into a substance like a bunch of cotton.

My Father, with the view of discovering the structure of this gland, threw a penetrating injection into the spermatic artery, but could not discover any appearance of acini at the terminations of the arteries.

The testes, therefore, are glands of a very simple construction. According to my Father, the seminiferous tubes of the

testicle do not exceed the $\frac{1}{200}$th part of an inch in diameter; and, when filled with mercury, the $\frac{1}{120}$th part of an inch.

The convoluted seminiferous tubes are cylinders, and do not join into trunks like the ducts of other glands, but pass into the rete testis at the back of the testis, where the epidydimis is joined to it. My Father has calculated, that the testis consists of 62,500 tubes, supposing each to be one inch long; and that if the tubes were united, they would be 5208 feet and 4 inches long. The epidydimis is proportionally larger in the fœtus than in the adult.

The ducts which come out from the testicle communicate, or there is a Rete Testis; the several tubes are joined by cross branches, one running into the other, in an irregular and uncertain manner. On account of the small size of the tubes of the testicle, it is extremely difficult to speak decidedly as to their structure. To the touch they are firm, and their coats are of considerable toughness, as is evident by their supporting a considerable column of mercury; and it is probable that they are endowed with a muscular power, though the muscular fibres be not evident to the naked eye.

In proof of the muscular power of the seminiferous tubes, it may be observed, that the testes swell when the vas deferens is irritated; and that, in the dog, as the vesiculæ seminales are awanting, the semen, during coition, is brought from the testes. The semen passes from the body of the testicle to the epidydimus, by twelve or fourteen straight tubes, called *Vasa Efferentia.*

My Father discovered that the greater part of the epidydimis consists of a single tube; in proof of which he has observed *: "Quapropter, ut, de ejus fabrica, ex facili et certo certius constaret, sequentia experimenta prius exposueram †; nempe si, inter infundendum mercurium, ullæ epidydimidis parti, præter caput ejus, vas crepuerit, vel si unum tantum vas vinculo constrinxerimus, nos frustra, ultra rupturam aut vincturam, mercurium propellere conari. Vel, si epidydimi-

* Vide his Dissert. Med. Inaug. de Testibus, p. 31.

† Edin. Phys. Essays, vol. i. art. 16.

da transversim dissecuerimus, deinde mercurium vi insigni in vas deferens adegerimus, per unicum tantum epidydimidis sectæ orificium prosilire. Quæ quidem experimenta extra dubitationem clare evincunt, totam epidydimida, præter caput, unico funiculo miris modis flexo constare, dum in quibusdam animalibus, ut postea patebit, organorum tenuitas aut structuræ perplexitas nullum aliud hujus rei veritatis argumentum perspicuum admittunt. Ex illo autem tempore, epidydimida mercurio turgidam, variis in partibus, in vas unicum subtile sæpius resolvi, ne quidem mercurii guttula effluente."

From the above, it follows, that the course of the semen might be interrupted by a wound or puncture of the seminal tube composing the epidydimis. My Father met with a case in which the epidydimis suppurated, and the semen was discharged by the wound for several months.

My Father also endeavoured to determine how much of the epidydimis is formed of the vascular cones, by filling it with quicksilver, and carefully dissecting it, so that none of the quicksilver should run out. He found that about one-third of it is formed by vascular cones, which gradually unite into a single tube.

The epidydimis is, in some very rare instances, divided into two branches.

There is sometimes a small seminal tube two or three inches long, which has a blind end leading out from the epidydimis, and this tube sometimes follows a tortuous course.

From the epidydimis, the semen is conveyed through the vas deferens to the vesiculæ seminales.

These small tubes take their origins from the inferior and posterior parts of the epidydimis, and continue their route along the back part of the spermatic chord.

The vas deferens is internally very small in proportion to its outward size, the coats being of considerable thickness and hardness; so that, when pressed between the fingers, the tube feels like a piece of whip-cord.

The vasa deferentia ascend through the under abdominal apertures, to the upper abdominal apertures, where they are detached from the spermatic chords, and pass downwards

and backwards across the psoæ muscles, and are fixed, by cellular substance, to the sides of the bladder, descending obliquely from without inwards: they pass behind the umbilical arteries; and cross the ureters, near to the lower part of the bladder, at which place they are firmly connected by short threads of cellular substance to the intestinum rectum.

The vas deferens, in its progress downwards and towards the under and back part of the bladder of urine, gradually becomes larger. The vasa deferentia are placed between the vesiculæ seminales, and are at length united to them very near to the base of the prostate gland, where they are connected to the rectum by cellular substance, and hence may be injured when the bladder is punctured from the rectum.

The vasa deferentia, on approaching the vesiculæ seminales, follow a tortuous course, and assume somewhat of a spongy appearance: they pass behind the vesiculæ seminales, and join with the vesiculæ, very near to their termination, at an acute angle; and, before the vasa deferentia enter the vesiculæ seminales, they are considerably contracted.

The smaller extremities of the vasa deferentia are united laterally to the anterior and smaller extremities of the vesiculæ seminales: the membrane which is placed between the vasa deferentia, is thin and moveable; and, when pressed backwards, prevents the reflux of the semen into the vasa deferentia.

Any fluid readily passes from the vasa deferentia into the vesiculæ seminales; and their contents, which are of a yellowish colour, are found to be similar, in all respects, to those of the vesiculæ seminales.

The ducts common to the vesiculæ seminales and vasa deferentia, are about an inch and a half long, of a tapering form, and pass into the urethra after having perforated the prostate gland. The orifices of these ducts may be observed on the opposite sides of that body, which is placed in the under portion of that part of the urethra called *Caput Gallinaginis*, from its supposed resemblance to the beak of a wood-cock. Around these orifices of the ducts common to the

vasa deferentia and vesiculæ seminales, there are several small orifices: these are the ducts of the prostate gland.

Of the Vesiculæ Seminales.

The vesiculæ seminales, which are included in distinct sacs, are equal in length to the breadth of 3 or 4 fingers, and nearly three times as long as broad: but their length, and also their breadth, materially differ in different individuals; and sometimes the vesicula of one side is larger than that of the other.

Castration has an obvious effect upon the size of the vesiculæ; by mutilation, they shrink considerably in size. Even in the same animal, they differ in size at different seasons, as in birds; they shrink in these animals, during the winter months, to a small size, but expand to a considerable bulk in spring.

The vesiculæ are of an oblong form, and are placed obliquely in respect to each other, between the most dependent part of the bladder of urine and rectum, to both of which they are connected by loose cellular substance. By their anterior and narrow extremities they are united to the prostate gland, and their broader rounded extremities diverge upwards and outwards from each other, and terminate in a narrow extremity, very nearly opposite to the entrance of the ureters into the bladder of urine.

When the fat and cellular substance which envelopes the vesiculæ seminales has been carefully removed, the surface of the vesiculæ are found to be irregular, somewhat like to that of the brain; and, between the convolutions, the bloodvessels proper to the vesiculæ are placed.

The outer membrane proper to the vesiculæ is of a pale brown colour; has a shining surface; and the irregularities of the surface catch the light, which gives them a brilliant appearance. The internal coat of the vesiculæ seminales is a mucous membrane, from the surface of which a mucous fluid is secreted.

There is no appearance of muscular fibres upon the vesicu-

læ; and hence they are perhaps emptied by the contraction of the levator ani muscle.

By carefully removing the cellular membrane between the convolutions of the vesiculæ, they may be unravelled, and converted into a straight tube, about the size of an ordinary sized goose-quill, which terminates in a blind end, with several lateral branches, which also end in blind sacs.

My Father, in his thesis upon the structure of the testes, has thus described the structure of the vesiculæ seminales:—

"Avibus et piscibus cartilagineis, vasis deferentis extremum ampliatum, vesiculam simplicissimam efformat.

"Homini et quadrupedibus plerisque, quum vas deferens vesiculæ seminali parallelum fere descendat, et ejus ductui per angulum acutissimum inseratur, semen exinde in vesiculam cursu retrogrado ascendit.

"Quadrupedibus nonnullis, muri, v. g. et sorici, vesicula evidenter, et nulla prævia dissectione, ex ampulla cæca, cujus lateribus intestinula cæca minora annectuntur, conflatur. Homini et quadrupedibus aliis plerisque, quanquam eadem in genere fabrica obtineat, cum tamen intestinum princeps plicetur, et plicas et cæcas appendices religent telæ cellulosæ, fabrica ejus perspicue, scalpelli ope, demonstrari nisi difficulter, non potest, et omnes præter HALLERUM anatomicos * latuit; qui nuper vesiculas cera repletas, et, dissectis patienter cellulosis, dissolutas depinxit †. Multum invenit in appendicibus diversitatis, in longitudine, simplicitate, directione, diametro. Et in iis quas explicui diversitas maxime quidem insignis est: in aliis vix ultra appendices 3 vel 4 vidi, in aliis 20 fere, et ex iis plures iterum ramosas. Modo autem vesiculæ cera repletæ membranas sine plicarum dissolutione auferamus, veram aptissime fabricam detegimus. Multis etiam quadrupedibus structura difficilioris adhuc quam in homine indaginis est; exemplo sit erinaceus."

The vesicula of one side is sometimes wanting; and, in that

* Leal Lealis et H. Bassius, uterque veri quid simile, sed omne verum non dixerit.

† Vide Phil. Trans. N°. 494. § 12.

case, the extremity of the vas deferens is considerably dilated. There is another variety in the structure of the vesiculæ which sometimes occurs, viz. the vesiculæ resemble pyriform bags.

The vesiculæ seminales are supplied with bloodvessels from the pudic arteries.

Meckel of Berlin has described particularly the absorbent vessels of the vesiculæ.

On opening the vesiculæ, they present a sacculated appearance, which corresponds with the elevations on the surface. These sacculi are various in size, figure, and number, in different vesiculæ; and, in these sacculi, a yellow coloured fluid, possessing a certain degree of viscidity, is contained. The inner surface is lined by a fine mucous membrane, which has been supposed to possess a follicular structure (which, however, I have not yet seen), from which a peculiar liquor is derived.

Castration has a striking influence upon the size of all the organs of generation. The penis is proportionally much smaller; the corpus spongiosum and corpora cavernosa penis do not admit of the same degree of distention as in the more perfect animal: the erectores penis and acceleratores muscles are thinner, and paler in colour; and the prostate gland is also smaller.

Of the Human Semen, and Contents of the Vesiculæ Seminales.

The human semen, when recent, is a viscid, glutinous, heavy fluid, which emits a very peculiar mawkish odour. The semen probably acquires its white colour from its admixture with the liquor of the prostate gland, as on pressing the ducts of the prostate gland after death, a quantity of white and opaque fluid exudes from these ducts.

When semen is rubbed in a mortar, it becomes frothy. It renders paper stained with violets green, and hence it probably contains an alkali.

Semen, about twenty minutes after its emission, becomes quite liquid.

Ammonia is formed during the exposure of semen to the air.

When exposed to the air, it deliquesces, becomes pellucid, and perfectly liquid.

A hundred parts of the semen, according to VAUQUELIN *, contain 90 of water, 6 of mucilage, 3 of phosphate of lime, and 1 of soda.

The semen also, contains a great number of living bodies, which have been said to have a rounded head, with a gently tapering tail †, and which are a thousand times smaller than a hair.

These small animals may also be observed in the semen of quadrupeds, reptiles, birds and fishes.

BUFFON has stated, that the description by LEUENHOECK of these small animals in semen, is incorrect; he observes, they are destitute of tails.

The more recent observations of SPALLANZANI, on this subject, accord perfectly with the original description of LEUENHOECK.

Mr J. HUNTER ‡ has described the contents of the vesiculæ seminales, in two persons who died violent deaths, as different from semen, as being in one "of a lightish whey colour, and having nothing of the smell of semen, and as being so fluid, as to run out on cutting into them;" and in the other, the fluid was lighter than is usually found in those who have been dead a considerable time.

If the vesiculæ be glands which secrete mucus, as there is so free a communication between the vasa deferentia and vesiculæ seminales, it seems probable, that a certain proportion of semen must, in all cases, be mixed with the contents of the vesiculæ seminales. A part of the semen is probably absorbed, which communicates a peculiar fœtor to the flesh of animals during the rutting season; and hence the difference in the flesh of the castrated and perfect animal.

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* Annal. de Chim. tom. ix. p. 64.

† Vid. LEUENHOECK's description of these Animals.—London Phil. Trans. n. 143.

‡ Vid. his Observations on the Animal Economy.

Of the Testes of the Fœtus.

The testes of the fœtus in utero are very small, and nearly of the same form as in the adult. They are placed below the kidneys, and are fixed to the fore-part of the psoæ muscles by peritonæum, and with their edges directed somewhat forwards.

The testes are of a yellowish grey colour, and of a soft and pulpy texture.

The peritonæum covers the body of the testes: the vas deferens descends, and is turned inwards below that process of peritonæum which Mr J. Hunter has called the *Gubernaculum*, along the bladder of urine; at this period there is no spermatic chord.

According to Mr Hunter, the gubernaculum is soft and vascular, and is covered by the fibres of the cremaster muscle, which is directed upwards, and lost upon the peritonæum, near to the testes.

About the eighth month the testes generally descend from the abdomen, through a canal formed by the peritonæum, together with the spermatic vessels.

At first there is a direct communication between the cavity of the abdomen and the vaginal coat of the testicle.

Before the testes have reached the scrotum, it is very small, and much corrugated.

The testes generally descend (or as the head of the fœtus is generally undermost, ascend) into the scrotum about the seventh month, frequently later, and sometimes not until the period of puberty: in some instances they have remained in the abdomen throughout life.

When the testes have reached their destined situation, the canals through which they had passed are generally obliterated, but, on other occasions, the canals through which they have passed remain open, or are shut at their top or middle only.

Wrisberg, who has devoted much attention to this department of anatomy, gives a table of 103 births.

The children, whose weight did not exceed 5 lb., were

born in the seventh, eighth, or beginning of the ninth month. Three had both testes in the scrotum; in three they were lodged in the groin; and in three they were found in the abdomen.

In 12 out of these 103 cases, where one or both testes remained in the abdomen, in one the testes reached the scrotum on the day of birth; in three it took place on the second day, in an equal number on the third, in two on the fifth, and in one on the twenty-first day; and in the remaining individuals, they had not reached the scrotum on the fourth and fifth weeks.

The preceding account of the original situation of the testicle, and of its subsequent descent, explains the difference between that kind of hernia called *Hernia congenita*, and the common scrotal hernia.

In the former, the inguinal canal is open, and the protruded portion of intestine follows the testis into the scrotum, and incloses it; whereas, in the latter, the protruded intestine and testicle are contained in distinct sacs.

In many adults, the canals through which the testes pass are not completely obliterated, but only a little constricted; and hence a hernia congenita is occasioned by some violent exertion, which forces the constricted canal.

There is considerable difficulty in reducing such a hernia, owing to the orifice of the hernial sac being much contracted above the under abdominal aperture.

The name *Congenital* is objectionable, as conveying an incorrect idea of the precise nature of the disease, which is more frequent a short time after birth than at the moment of birth, and sometimes does not shew itself until manhood.

The stricture, in this kind of hernia, may be seated at the top, or in the middle of the canal: hence the size and figure of this hernia is various; if, for instance, the stricture be near to the under part of the canal, the tumour will be of an oblong form, and equally large at its upper and middle part; and the tumour passes out perpendicularly from the abdomen, because the spermatic chord of an infant, when newly born, does not pass obliquely through the parietes of the abdomen.

It often happens, that the testes and protruded portion of intestine adhere to each other, and, therefore, an attempt to return the protruded portion of intestine proves a cause of very acute pain.

SECTION IX.

OF THE PROSTATE GLAND.

This gland is placed obliquely, in respect to the trunk of the body, between the intestinum rectum and bladder of urine, to both of which it is connected by cellular substance, and a ligamentous membrane, and beneath, or rather behind, the symphysis pubis.

In shape it somewhat resembles a Spanish chesnut, and there is a depression in the middle of the broader extremity of it; hence it has been described by anatomists as consisting of two lateral lobes, the sides of which are rounded and covered by portions of the levatores ani.

The bladder of urine is connected with the anterior and upper part of this gland, for the greater part of its upper surface, which is somewhat concave; but this gland is convex, where it is connected with the intestinum rectum.

When the intestinum rectum has been much distended, it incloses this gland to a certain extent.

On account of the contiguity of the rectum to the prostate gland, an enlargement of the prostate cannot fail to impede the free exit of the fæces.

On removing the capsule, within which the prostate gland is inclosed, the body of the gland is found, a few hours after death, to be of a purple colour, uniform in its surface, and covered by some fat and cellular substance, in which a plexus of large veins is lodged, and also the smaller branches of an artery, which are derived from that artery which supplies the bladder of urine.

The prostate gland, when pressed, feels firm, and not unlike to the unimpregnated womb, being considerably harder than any other gland of the human body, and communicating the same sensation, when divided by the knife, as the virgin uterus: hence the reason why this gland opposes so much resistance to the knife in performing the lateral operation of li-

thotomy, and also the cause why the instrument occasionally does not pass through that gland, but slips backwards into the sac, between the bladder and rectum.

If the stone be of great size, incisions of the usual size are inadequate to the giving free passage to the stone; the parts are bruised or lacerated, if the stone be not broken *.

For the sake of more accurate description, I shall suppose the dead body to be placed in the horizontal position.

This gland may be divided into a basis or broader end, and an apex or narrower end, between which, what may be called the *body of the gland*, intervenes.

The basis and body of the gland are placed rather behind than immediately under the symphysis pubis, to which it is firmly fixed by a portion of the levator ani muscle.

The basis or larger end of the prostate gland inclines upwards and backwards; is fixed by a ligamentous membrane, and by cellular substance, to the anterior extremities of the vesiculæ seminales and vasa deferentia; and the apex, situated behind the arch of the pubes, looks downwards and forwards.

In dividing the prostate gland when performing the lateral operation of lithotomy, care should be taken to divide the lateral lobe of the prostate gland in the axis of the pelvis: thus the incision is made above the level of the vesiculæ seminales, and there is little risk of wounding the rectum.

Dr Camper, in one of his valuable engravings of the pelvis, has pointed out very clearly, the direction in which this gland should be divided, in performing the lateral operation of lithotomy.

This gland, which is thicker in the transverse than in the vertical direction, is generally composed of two lobes only, which are similar in size, and which are separated from each other by a distinct furrow, which is not equally distinct in all individuals.

Each of these lobes is somewhat rounded on their surfaces.

* Vide Mr Earle's Observations on the danger of extracting large Calculi, and his account of an instrument for breaking down large stones.—Med. Chir. Trans. of London, vol. xi.

On separating the vasa deferentia from each other, we, on some occasions, meet with a third lobe, which is placed posteriorly in respect to the urethra, between the lateral lobes. This third lobe has been described by MORGAGNI, J. HUNTER, and Sir E. HOME.

MORGAGNI has observed, Adv. Anat. iv. page 24, and 25., 1723, "Quod si vera ulla propago prostatæ addenda est, ea certe est subrotunda et renitens, quasi glandula, quam cum sæpe diligentissimus noster incisor in publicis dissectionibus animadvertisset inter vesicam et seminales capsulas qua sese mutuo jam contingunt prominentem, et nonnunquam ad angulum quem, conveniendo, efficiunt, prostantem, nos, accurato instituto examine, nihil aliud esse comperimus quam corporis prostatæ ipsius particulam." An enlargement of the whole, or of a part of this gland, alters the course of the urethra; it increases its curvature upwards; and if the enlargement be limited to one of the larger lateral lobes, the urethra follows a winding course.

If both lateral lobes be swelled, the urethra is obstructed; but, generally, the obstruction is occasioned by the third lobe projecting backwards, and forming a sort of valve over the orfice of the urethra; for it is forced downwards by the contraction of the bladder.

Several specimens of the enlargement of this third portion of the prostate gland, have been preserved in the Museum of the University of this city for thirty years.

Of the Use of the Third or Middle Lobule of the Prostate Gland.

1*st*, MORGAGNI thought this protuberance, or *Caruncle*, as he calls it, may serve to defend the vesiculæ seminales from the compression of the distended bladder of urine. MORGAGNI, Adv. Anat., page 24. 1723, "Non sine aliqua utilitate in iis qui hanc habent (neque enim omnes habent) ut puta, ad easdem capsulas a compressione distendo vesicæ defendendas, antalia ejusmodi, inter hanc et illas protuberantem."

To me it appears to be rather calculated to serve the follow-

ing purposes. In the 1*st* place, For making gentle pressure by its posterior part, upon the ducts common to the vasa deferentia, and vesiculæ seminales, when the bladder is distended; and especially when we are endeavouring to empty it, in order to prevent the pressure of the distended bladder upon the vesiculæ seminales, from occasioning the discharge of the semen into the urethra.

2*d*, The anterior part of this protuberance seems to me, as it did to Mr John Hunter, to serve also, in some degree, as a valve, to prevent the too ready discharge of the urine.

The third lobe, when sound, is not larger than a small pea; but in consequence of disease, it often attains a large size, and, projecting into the bladder, proves an impediment to the exit of the urine, by forming a sort of valve over the orifice of the urethra; and, in this case, the greater the action of the muscular fibres of the bladder, the greater the impediment to the exit of the urine *.

At the under part of the neck of the bladder, there is a space between the entrance of the ureters and urethra, which is nearly equilateral. This has been called *Trigone*. It is elevated somewhat above the level of the inner surface of the bladder, especially between the orifices of the ureters. The mucous membrane that lines this part of the bladder is thinner, more sensible, and paler in colour, than that of any other part of the bladder; and, under it, there is a plexus of veins, which was discovered by the late Mr Wilson of London, and which he has particularly described in his book on the urinary organs.

When the free egress of the urine is impeded, the trigone is enlarged, especially between the orifices of the ureters, owing to the enlargement of the muscular fibres; and it forms a well-defined ridge, behind which a calculus is sometimes lodged.

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* Sir E. Home observes, "The enlargement of the third lobe often keeps pace with that of the lateral lobes, so that there is no passage either on the one side or the other. The middle line of the urethra is that, in which a catheter will most readily come at the bladder."

When the gland is divided, it is found, internally, to be of a spongy consistence. It tears readily in the direction in which it is cut; and I suspect is frequently lacerated during the performance of the lateral operation of Lithotomy, especially when a large stone is extracted from the bladder.

Mr Deschamps of Paris, made many experiments on this gland; and discovered, that if the point of this gland, the most resisting part of it, be cut to the depth of three lines, and then slowly and cautiously dilated, a stone 8 lines in diameter may be extracted without laceration of the neck of the bladder, or of the rest of the prostate gland, which, he says, is more dilatable than the membranous part of the urethra; that, in an adult, if the incision be 6 lines deep, a stone 14 or 15 lines in diameter, may be extracted; if the incision is 8 lines deep, a stone 18 or 19 lines in diameter, and weighing about 4 ounces, may, without laceration, be taken out; but a stone above this size will require the incision of the whole depth of the prostate gland, at its uppermost thickest part, which measures about 9 lines. These experiments have distinctly proved, that a stone of considerable bulk may be extracted by the lateral method of cutting for the stone.

Of the Ducts of the Prostate Gland.

My Father, soon after he began to lecture in this University, directed his attention to the structure of this gland; and discovered, after very successful injections of the ducts, "that although this gland secretes a whitish mucous liquor, it is not lodged in follicles, as Bidloo and Cowper have represented, but that the whole gland is composed of cylindrical ducts, the beginnings of which are so small as to escape the observation of the naked eye. The ducts, by their convolutions, form small lobules; and from each lobule ducts not larger than the hairs in the tail of a horse come out; and these, in their course towards the urethra, join together in the same way as the ducts of the salivary glands, or those of the mamma.

The ducts of the prostate gland are frequently much enlarged, when the urethra has been constricted, which proves

a cause of difficulty in passing a bougie into the bladder of urine.

A number of bloodvessels are distributed on the coats of these ducts, and also nerves and lymphatic vessels.

The urethra generally passes through the upper part of the gland; but it is proper to remark, that it is not always so; for, in some occasions, the urethra is only partially enclosed within this gland, as Dr P. CAMPER has observed. His words are, "Ex his omnibus concludere licet, glandulam prostatam *in permultis, si non omnibus, integram urethram amplexari.*"

This gland is covered by a plexus of large veins, which unite with the veins of the bladder: and which veins, when divided in performing lithotomy, may pour out a good deal of blood. The arteries of this gland are derived from the internal pudic arteries. Nerves from the fourth and fifth sacral, and also from the plexuses of the intercostal nerves, supply this gland.

The fluid which is derived from the prostate gland, is of a white viscid nature.

I had occasion to visit a medical gentleman of seventy-three years of age, who informed me, that he at times suffered, for many years, under very considerable uneasiness in the neck of the bladder, especially after full living, together with very frequent calls to pass his urine, along with which he always discharged a liquor of a pale, brown-colour, which tinged his linen, and which he supposed to be derived from the prostate gland *.

The following observations are derived from 17 preparations of enlarged prostate, in the Museum of this University, and in that belonging to myself.

The whole mass of the prostate is, in many cases, increased in its transverse diameter from 2 to $3\frac{1}{2}$ inches, and from 2 to $2\frac{1}{2}$ inches in its depth from its fore to its back part. The lateral lobes are enlarged, and nearly equally so in the majority of the specimens. In four, the left lobe is most enlarged, and

* In the healthy state, the liquor secreted by the prostate gland has a whitish colour.

in three, the right; and, in one of these, a tumour, formed by the third lobe, as large as a walnut, ascends from it into the bladder.

In three specimens, a semicircular tumour ascends from the upper part of both lateral lobes into the bladder.

In four, the third lobe, which is not of an uniform figure, is enlarged, and ascends some way into the bladder.

In all the specimens where one of the lobes is more enlarged than the other, the neck of the bladder is elongated, and follows a tortuous course; so that, when a catheter of the ordinary length is passed, it does not reach the bladder; and when the space between the lateral lobes is widened by the swelling of the lateral lobes, when the point of the catheter is within the enlarged part of the urethra, it may be passed readily from side to side, or up and down, which leads the surgeon to suppose his instrument is within the bladder; and the more especially as, owing to the distention of the bladder, the urine comes away drop by drop, and the disease may be mistaken for an incontinence of urine. But, when the third lobe is enlarged, the urethra is contracted, and is turned upwards suddenly on approaching the bladder: hence the use of employing a flexible catheter, or one that is more bent than usual near to its point, and of depressing the handle of it, when it is to be passed into the bladder *.

In all the specimens, the muscular fasciculi of the bladder are enlarged. In one specimen, cysts were formed between the principal fasciculi, which contained urinary concretions, and other calculi were in the open cavity of the bladder.

In another preparation, where the whole bladder was much dilated, there were very large cysts between the muscular fasciculi, but no calculi were lodged in them; but, in the cavity of the bladder, *there were six lamellated spherules, about the size of peas, with long spiculæ growing out from them, which*

* Sir E. Home has stated, "That, in some instances, the internal changes in the structure of the prostate gland are produced by extravasation from rupture of vessels in different parts of its substance, and that the increase in size is more or less rapid, according as the vessels are larger or smaller."—*Pract. Obs. on the Prostate Gland*, Lond. 1818, p. 26.

resembled those cartilages which are occasionally found in the joints and bursæ mucosæ.

Of Cowper's Glands.

These two glands are generally so named from COWPER, the Author who has most fully described them; sometimes they have been called the *Inferior Prostate Glands.*

They are of a pale red-colour, about the size of a garden pea, and are situated on each side of the bulb of the urethra. Each gland has its proper excretory duct, which is about half an inch long, and which perforates the membranous part of the urethra with a certain degree of obliquity.

I have found it impossible, in some instances, to discover these glands; and, in other instances, they are remarkably small.

We are as yet ignorant of the nature or use of the fluid secreted by these glands.

SECTION X.

OF THE LATERAL VIEW OF THE CONTENTS OF THE PELVIS OF THE MALE.

HAVING described the structure of the contents of the pelvis of the male, it may not be improper to direct the attention of the reader, in a more particular manner, to the relative situation and connection of those organs, which are seen most distinctly in the side view of the pelvis.

The lateral view of the pelvis, which is had by removing the greater part of one of the ossa innominata, affords by far the most instructive view of the relative situation and connection of the contents of the pelvis.

Drs CAMPER and ROSENMULLER removed one of the ossa innominata entire, by dividing the symphysis pubis before, and the sacro-iliac symphysis behind, but it is better to leave about one and a half inch, or two inches, of the os innominatum adhering to the other os innominatum, by which the at-

tachments of the triangular ligament and of the levator urethræ muscle of Mr Wilson of London are preserved.

The contents of the pelvis of the male are,—the bladder of urine, and its connecting ligaments, with a portion of the ureters, the intestinum rectum, the vasa deferentia, vesiculæ seminales, and prostate gland, together with the fat, cellular substance, muscles, membranes, ligaments, bloodvessels, nerves, and absorbent vessels proper to these parts.

After removing the greater share of one of the ossa innominata, it is not easy to distinguish the several bowels of the pelvis, unless a sound be passed into the bladder, and unless the bladder of urine and rectum be somewhat distended with air.

On tracing the peritonæum, we find it descending in the male from the navel towards the ossa pubis, covering the shrivelled umbilical arteries and urachus. It covers the posterior surfaces of the recti and pyramidales muscles, and is then reflected upon the upper and fore part of the bladder of urine, from which it passes backwards, as far as the base of the vesiculæ seminales, and it is reflected to the anterior surface of the upper part of the intestinum rectum, but, it may be observed, that the place of the reflection is by no means uniform in all cases.

This reflection of the peritonæum has been said by some authors to constitute the posterior ligament or ligaments of the bladder.

The rectum, at its lower part, and also at its sides, is covered by the peritonæum, which membrane, being continued behind that bowel, forms what has been called the *Meso-rectum*, by which it is fixed to the os sacrum.

Considering the very limited plan of this elementary work, I must content myself by adding a few very general observations respecting the puncturing and cutting into the bladder, omitting entirely all remarks upon the striking degree of sympathy which exists between the bowels of the pelvis; the influence of remedies thrown into the rectum upon the bladder, and womb; the effect of the displacement, or increased bulk of any one bowel in deranging the functions of the con-

tiguous bowels, or in bringing about an alteration in their situation, and also respecting the propagation of inflammation and other organic derangements from one bowel to another.

Before proceeding to perform the operation of lithotomy, the age, state of body, and posture of the patient, merit attention. I have frequently seen the operation performed on boys between six and twelve years of age with success. CHESELDEN cut 105 under ten years of age, of whom only three died; four out of sixty-two died, who were between the tenth and twentieth year; and thirteen died of those between their twentieth and eightieth years.

The above statement corresponds with general observation, inflammation being more apt to succeed the operation in the meridian of life.

Children of two or three years of age are not fit subjects for lithotomy; the constitution at that tender period being very irritable, convulsions often ensue, which carry off the little patient.

If the constitution be broken, or if the patient has laboured for some time under the stone, as by it the coats of the bladder are thrown into a morbid state, the operation is generally unfortunate. If there be reason to suspect the kidney to be diseased, as is shewn by pain in the loins, and by blood or pus being discharged along with the urine, or if the prostate gland be diseased, it is dangerous to operate.

A deranged state of the functions of the alimentary canal is unfavourable to the operation of lithotomy: in these circumstances a good deal of air is generated, by which the rectum becomes much distended, and very liable to be wounded during the performance of the operation.

The posture of the patient during the operation merits the particular attention of the surgeon.

If the surface of the table on which the body is placed, slopes downwards, a portion of the smaller intestines slips into the pelvis, and presses downwards the bladder of urine.

In France, we are told by Mr SHARP *, " their bodies are

* See Critical Enquiry, 4th edition, p. 216.

raised so high as to make an angle of about 45°. I cannot say I have heard any reason assigned for this great elevation of the body, but perhaps it may be done with a view to promote the falling down of the stone towards the neck of the bladder;" an advantage which, in my opinion, is very much counterbalanced by the forcing downwards of the bladder and rectum, which are thereby more liable to be cut.

There are instances recorded by Mr Bromfield * and others, in which the opposite side of the bladder of urine has been wounded, and the intestines have passed through the cut in the coats of the bladder, which may have been in part owing to the improper position of the patient.

On the other hand, it seems objectionable to elevate the buttocks of the patient upon pillows, as has been recommended by several surgeons of eminence, as thus the incisions cannot be made in the most proper direction,—the axis of the pelvis; and besides, the stone falls back into the fundus of the bladder.

In sounding a patient, with a view to discover a stone in the bladder, pillows under the hips are sometimes of use: thus the stone is thrown into the fundus of the bladder, and may there be perceived when it could not be felt in other circumstances.

In short, it seems to be most adviseable, to put the body of the patient upon a table, the surface of which is on a level with the breast of the operator, and to place the buttocks of the patient on the edge of the table.

The patient is to be laid on his back, with his feet supported on a chair, and his knees separated from each other, and raised, so as to expose the parts to be divided.

On account of the vicinity of the rectum to the bladder of urine and urethra, in passing a catheter or staff into the bladder, the introduction of one or two fingers into the rectum facilitates the entrance of these instruments into the bladder. When there is any difficulty in passing the instrument in this manner, we feel exactly how far the instrument has

* See his Chirurg. Obs. and Cases, vol. ii.

penetrated. By pulling downwards the rectum and anus, the membranous part of the urethra is stretched, by which the instrument passes more readily into the bladder of urine. When the instrument has got beyond the membranous part of the urethra, and is lodged within and covered by the prostate gland, with a little address, it may be passed into the bladder.

If there be reason to suspect that the instrument has ruptured and passed through the membranous part of the urethra, which it may be concluded has happened, if the urine does not flow through the catheter,—by the patient suffering acute pain when the handle of the instrument is depressed,—and by the point of the catheter being felt between the rectum and bladder, whilst, at the same time, the prostate gland is felt very indistinctly,—the instrument should be withdrawn, and no further attempt made to pass it until the wound in the urethra has healed, which generally happens sooner than might have been expected.

If the point of the staff be fairly within the bladder. the handle of it falls down; and the instrument is very moveable within the bladder.

As the stone generally lies in the pouch behind the neck of the bladder, if we do not strike the stone at first, that may be done by drawing backwards the instrument, and by changing the position of the patient.

The surgeon, immediately before commencing the operation, should satisfy himself by the staff, that he feels the stone in the bladder, as it may have passed into a cyst, though loose, within the bladder, when he had previously sounded his patient.

On account of the vicinity and connection of the rectum to the bladder of urine, it is possible to feel and distinguish the size of a stone by the point of the finger, within the rectum, provided the coats of the bladder have not been previously thickened and indurated (which often happens) when a patient has been, for a long time, afflicted with stone.

Different methods have been proposed for the extraction of a stone from the bladder of urine.

On account of the vicinity and connection of the bladder to the rectum, stones may be extracted from the bladder, by cutting into it from the rectum.

Celsus, the first author who wrote *on lithotomy*, adopted this method of operating.

It is not applicable to the adult, for the operator cannot reach the stone, so as to grasp it: even in a tall young person it could not be done; and even when the stone could be grasped, it might be impossible to press it downwards, to a proper part of the perinæum, for making the incision. Besides, the places cut are not the same in any two operations, and the incisions are made without any proper rule; and by the incisions, the vasa deferentia, or vesiculæ seminales, will probably be injured, to a greater or less degree.

Of late, a different method of cutting into the bladder from the rectum has been proposed, by a French surgeon, Mr Sanson. He divides the sphyncter ani muscle from below upwards, and opens the membranous part of the urethra, and the prostate gland, from above downwards.

This method of operating has been, of late, repeatedly practised by the Italian surgeons, and especially by Dr Vacca Belinghieri, who is a very warm advocate for it; and has published a memoir, in order to point out its peculiar advantages. According to that author, there are several advantages peculiar to this method of opening the bladder: "there is no point of the perinæum nearer to the bladder than that which is immediately anterior to the sphyncter ani.

"By cutting the sphyncter, the parietes of the rectum, the membranous part of the urethra, and the prostate, we shall have procured an opening sufficiently large for the entrance of our fingers, our forceps, and for the egress of the stone; because we take advantage of the natural aperture of the anus, and cavity of the rectum."

Upon the preceding paragraph, it may be observed, that a passage, sufficiently large for the extraction of a stone of considerable size, may be obtained by the lateral operation. The late Mr A. Wood extracted a stone, weighing 14 ounces, in presence of my Father, by the lateral operation; and his

patient recovered. This stone is a great deal larger than the greater number of urinary calculi; the average weight of which does not exceed 2 or 3 ounces. The passage is too small only when the lateral operation has been unskilfully performed.

If the reader shall take the trouble of perusing what has been stated as to the prostate gland, he will be convinced, by Dechamps's observations, that a stone, of very considerable diameter, may be extracted by the lateral method of operating; and a very large stone may be extracted by the high operation, whilst the patient is not exposed to the risk of a communication being established between the rectum and bladder of urine.

"An incision which divides the anterior part of the sphyncter ani, the membranous part of the urethra, in the middle line of its anterior (inferior) parietes, the neck of the bladder, the prostate and fundus of the bladder in the same line, does not approach any large vessel, or other part, important to life. The depth of the wound being less than by other methods, the surgeon is enabled to penetrate further into the bladder, to ascertain the form, size, and situation of the stone, previous to his grasping it for extraction."

This observation is undoubtedly correct; but the greater distance between the external parts and the bladder, is no objection to the lateral operation of lithotomy, as the inner surface of the bladder of the adult may be reached by the forefinger of most operators, if the patient be not very fat.

"By the recto-vesical operation, we are enabled to extract the largest stones, without the inconvenience of laying bare the peritonæum, and of exposing the surgeon to the risk of wounding it, or of the danger of extravasation of urine."

By this method of operating, no considerable artery is opened; but the large veins, coming from the penis, which, on entering the pelvis, form a plexus, which covers the prostate gland, may be wounded, and from these a good deal of blood may be lost.

The trunk of the internal pudic artery is so situated, and so well protected by the os ischium and ligamentous mem-

brane, which covers it, that it cannot be divided in performing the lateral operation of lithotomy, unless it deviate from its usual course, which I have never seen take place, or unless the surgeon has made his incision too much to one side, and too near the bone, or has used too broad a gorget.

I have seen the lateral operation frequently performed, without having witnessed, on any one occasion, such a bleeding as proved fatal, or was at all alarming; on the contrary, the few ounces of blood lost tend to remove the risk of internal inflammation, which is the most common cause of the death of persons who have been cut for the stone.

Besides, I have now before me, the history in manuscript, of 120 patients who were cut for the stone, by that celebrated surgeon Mr SMITH of Perth; and there is not a single instance mentioned, in which hæmorrhage occurred which proved dangerous.

In the above observations, I am borne out by the concurrent testimonies of those great surgeons Mr POTT, Sir J. EARLE *, Mr MARTINEAU †, and Professor SCARPA ‡.

The peritonæum may be cut, and the cavity of the abdomen exposed, by the recto-vesical operation, as the place of the reflection of that membrane, from the bladder of urine to the intestinum rectum, is not uniform; in some it is nearer to the anus than in others.

SCARPA has made mention of another objection to Mr SANSON's operation. "It cannot be performed without the division of the left seminal duct, or even of both, if the groove of the catheter be directed to the right side, and if, as is of-

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* "I speak from my own experience, and that of Mr POTT, that I never knew a *bleeding from an operation for stone prove of material or serious consequence.*"—*Vide Observations on the Operation for the Stone*, 2d edition, p. 79.

† "Not one (fatal case of hæmorrhage) has occurred, in the 574 patients cut in the Norwich Hospital; nor have I witnessed a fatal case in private practice."—*London Med. Chir. Trans.* vol. xi. p. 403.

‡ "*The certainty of not wounding the pudendal artery* is not an advantage of the recto-vesical operation exclusively: *the dread of such an event no longer occupies the minds of our operators, now that they are conversant with anatomy*, and skilled in the use of the scalpel."—*Vide his Letter to Mr* MAUNOIR *of Geneva, on the Recto-Vesical Operation.*

ten the case, they run parallel to, and in contact with each other, to the opening on the caput gallinagenis."

Of the Lateral Operation of Lithotomy.

Frere Jacques had the merit of introducing what has been called the *lateral operation of lithotomy;* and it was so named, because the side of the urethra, near to the bladder, is divided.

I subjoin the following observations on lithotomy, from a manuscript in my possession, drawn up by Mr Smith of Perth, whose case-book contains a list of 120 persons, on whom he had operated in the course of twenty years; of which number 54 were children.

"While I was apprentice to Mr Murray of Glencarse, I observed several patients come to him that were troubled with the stone in their bladder, which he declined cutting; that operation being then practised by no regular bred surgeon in Scotland, only by rude illiterate fellows, and that *by the gripe or apparatus minor.* I resolved, when at Paris, during 1703 and 1704, to get some knowledge of the method there used. Accordingly, I had the opportunity of seeing Monsieur Marechal, master surgeon in the Charity Hospital, afterwards chief surgeon to Louis Quatorze, cut many after the *apparatus major*, as it is called; and thinking myself sufficiently qualified for performing the operation, I bought a proper set of instruments, and soon after I came home, found patients enough to perform upon; and, I thank God, they, for some time, recovered all to my wish; yet, finding great difficulty in introducing the forceps, and still greater in extracting the stone, and hearing of Rau's way, I adopted it. Heister's account of Rau's operation is as follows.

"That he had been informed by Albinus, both father and son, together with Ruych, that he Rau, being assisted by a chirurgical audacity, and great skill in anatomy, first, like James, and the ancients, cut through the perinæum, then through the neck and bladder itself; that he made use of a grooved catheter to cut upon; that, instead of a gorgeret, he made use of two ensiform conductors, male and female; that

he placed his patients after the manner of Frère Jacques, lying on their backs, with their hips elevated; that he secured them by two short ligatures, made of flannel; each were not above four feet long. The patient being laid on the table, his wrist was fastened by one of the ligatures, by a loop to the leg of the same side, not to the ancle, as is the practice of others, but to the knee; and the same method was observed on the left side.

"I concluded that, in this way of Rau, the sphyncter of the bladder was cut, which made the operation every way easier. I immediately thought on trying this way, which I did by making at first a large oblique incision from the protuberant part of the staff, or catheter, towards the os ischium.

"I plunged the point of my knife or bistourie, which was two-edged, into the groove of the protuberant part of the staff; and, bringing the head, which I held with my left hand, forwards from the belly, the staff naturally went backwards into the bladder, and the bistourie being held fast by my right hand, and pressed on the convex part of the staff, followed into the bladder, and cut its sphyncter, so as the urine came rushing out in plenty; after this, the gorgeret, or conductors male and female, were easily introduced into the bladder by the groove of the staff, and the forceps, by the help of these; and then the forceps was easily dilated, so as to receive or apprehend the stone betwixt their branches; after which, I found no difficulty in extracting the stone. So that the grand secret of cutting for the stone, in my opinion, lies in cutting the sphyncter of the bladder, either the way described, according to Rau, or by Mr Cheselden's method of cutting from behind the prostate gland forward to the bulbous part of the urethra: and, in both ways, there always is cut an artery or two, which must be tied up with a crooked needle and thread, and thus the operation is ended.

"I also tried the high operation, or cutting the bladder above the ossa pubis; 4 of 12 patients died. Finding great difficulty to bring the wound to a suppuration, by the continual bubbling out of the urine through it, I gave up this way also, and continued to operate in Rau's way with tolerable success."

I shall subjoin a very few observations respecting the lateral operation of lithotomy, as it is now performed, referring the reader for a more particular statement to those books which treat professedly on that department of surgery *.

The operation is most readily performed when the bladder is moderately distended; for which purpose, the patient should be enjoined, a few hours before the operation, to drink freely of some weak tea, or other mild liquor, and to retain his urine, which is safer and less painful than the forcibly distending the bladder, by forcing a liquor through the urethra; which, according to Dr MIDDLETON, proved the most painful part of the operation.

After the hair has been removed from the perinæum, and the patient properly secured, and laid upon his back upon the table; that is, horizontal, and nearly on a level with the breast of the surgeon, the surgeon would do well to ascertain that the bladder has risen above the ossa pubis, which is a proof that *its coats are not thickened, and its cavity contracted*, which often happens to persons advanced in life, who have been for a long time afflicted by stone in the bladder; to trace with his finger the arch of the pubis, and the ascending branch of the os ischium, and also the exact place of the tuberosity of that bone, before he divides the skin, lest there should be such a malconformation of the bones as does not leave sufficient space for the extraction of the stone †. That the progress of the staff may not be interrupted by the contraction of the urethra, which otherwise would be excited by the cold steel, it should be previously put for a few minutes into tepid water, and afterwards well smeared with oil; and, after having been introduced, it is consigned to the management of a skilful assistant, whose business is to hold it very steadily, and to direct its convex part to the right, if the groove be in the under part of the staff; but if the groove be in the side of it (which is preferable), it is to be held vertical-

* Vide Dr DOUGLAS's History of the Lateral Operation of Lithotomy; DESCHAMPS, B. & J. BELL, ALLAN, CARPUE, COOPER's Surgical Dictionary, Art. *Lithotomy*.

† Vide Observations in Vol. i. p. 89., on the Distortion of the Pelvis.

ly. It may be observed, that it is of much moment to have the groove in the staff wide and deep, that it may be the more easily distinguished. Another assistant supports the scrotum. The operator, being seated on a firm stool between the thighs of the patient, which are to be separated and kept so by assistants, begins his incision, providing his patient be an adult, an inch and a half under the arch of the pubis, and continues it parallel to the descending ramus of the os pubis and ascending ramus of the os ischium, so far down as that it shall be about half an inch lower than the tuberosity of the ischium, and between three and four inches in length.

The incision should be very nearly half way between the anus and tuberosity of the os ischium; so that, at its upper part, it falls in upon the side of the corpus spongiosum urethræ and bulb of the urethra, and into that triangular space between the bulb and the crus penis.

By this procedure, there is little risk of injuring the bulb of the urethra, or the trunk of the pudendal artery; and sufficient space is given for the extracting a stone which exceeds the average size: an incision of such a length supersedes the necessity of enlarging the external incision, renders it easy to extract the stone, and prevents the parts from being bruised or torn by the forceps, which frequently proves the cause of death.

The first incision, the object of which is to divide the skin, cellular substance, tendinous membrane of the perinæum, and subcutaneous fat, should be made in the axis of the pelvis: by the next, the transversalis, and levator ani muscles, and branch of the pudic artery which enters the bulb, are to be divided; and, in the same direction, and during the time the incision is made, the bulb should be pressed to one side.

Before dividing the above muscles, it is prudent, by the fore finger of the left hand, to press down the rectum, lest it be cut.

Upon the above muscles being divided, the groove of the staff within the membranous part of the urethra may be felt by the finger. This may be readily divided by a short

bladed knife, the edge of which is to be directed upwards, and the cut in the membranous part is then to be extended backwards towards the prostate gland, in the same direction. For the division of the prostate gland and neck of the bladder, I have exhibited in my surgical lectures, for several years past, a scalpel, with a small button on its back, which fits into the groove of the staff, and slips along it into the bladder *. The implanting this button or beak of the gorget (if it be used), into the groove of the staff, and keeping it there, is the most difficult part of the operation. To be certain that the button on the back of the knife is in the groove of the staff, it is well to move it up and down; for, if it be not in the groove, it may pass sideways between the bladder and rectum. The surgeon must be careful that the button do not slip out of the groove, owing to the unskilfulness of the assistant, who may change the direction of the instrument, unsteadiness of the patient, or the resistance of the prostate gland and neck of the bladder, into the cellular substance between the bladder and rectum; for in such a case, the surgeon, supposing he had got into the bladder, might enter his forceps, and pinch and bruise the still undivided coats of the bladder.

To prevent the possibility of this very untoward circumstance, the button of the gorget invented by my Father is of such a form, that if it has been once inserted into the groove of the staff, in the membranous part of the urethra, it cannot get out of it, (unless it be broken off), until it is within the bladder.

Upon the bladder being divided, the forceps should be passed into it with their blades shut, in order that the situation of the stone may be discovered. This being accomplished, the blades are to be separated, the stone is to be grasped, and the stone withdrawn in the axis of the pelvis,

* I am much gratified to find, that LANGENBECK, one of the most distinguished surgeons on the Continent, uses a knife of the same form as I shewed, and which differs from mine only in being a little larger.—*Vide Mr* S. COOPER'S *First Lines of the Practice of Surgery*, 4th edition.

taking care to pull somewhat downwards, as otherwise the exit of the stone may be impeded by the arch of the pubis and the triangular ligament of the urethra.

Should the stone be broken within the bladder, the fragments may be got out by a scoop, and the smaller pieces will perhaps be forced out, if one or two pounds of tepid water be injected into the bladder, which injection has the further effect of removing blood that may be lodged within the bladder.

Of the High Operation of Lithotomy.

The bladder may be cut into above the ossa pubis, without opening the cavity of the abdomen, for, in the healthy state, a space equal to two or three inches intervenes between that part of the bladder, which is uncovered by the peritonæum, and the ossa pubis; and, in some cases, the bladder rises much higher above the symphysis pubis.

Mr Smith's experience is certainly not in favour of the high operation.

Mr Carpue has lately published a very full history of this method of cutting for the stone, and has recommended it as performed by Dr Souberbielle of Paris, who has had the merit of rendering it less dangerous; but still, there are many objections to this operation, which are ably stated by that distinguished lithotomist, Mr Martineau, in the eleventh volume, p 402. of the Medico-Chir. Trans. of London, to which I refer the reader.

Of Puncturing the Bladder.

The bladder may be punctured above the ossa pubis, or from the intestinum rectum.

The puncturing the bladder by a trocar above the ossa pubis is a very easy operation, when the bladder has risen freely above these bones.

It has been objected to this operation, that, by the canula being left in the wound, the back part of the bladder is irritated by the point of it, and apt to fall into a state of ulceration;

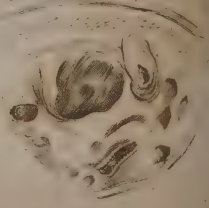
TAB. VIII.

To face Page 211.

Fig. 1.

Fig. 3.

Fig. 2.



but this is not apt to happen, if the instrument be passed obliquely downwards, or if the apparatus contrived for this purpose be employed *, or if an elastic gum catheter be left in the bladder, instead of the canula of the common trocar.

Some surgeons of eminence prefer the puncture from the rectum; but the constant tenesmus the patient experiences, the embarrassment he suffers when he goes to stool, the difficulty of keeping the instrument in its place, and of replacing it, the fatal consequences which sometimes result from the effusion of the urine, and the risk of wounding one of the vasa deferentia, lead me to prefer the former method; and, besides, a fistulous communication is sometimes the result of this mode of operating. Lastly, if the cause of the retention of urine be an enlarged prostate gland, the puncture from the rectum is inadmissible.

Explanation of Plate VIII.

This and the following plate were copied from the very careful dissections of my assistant Mr MACKENZIE, who took great pains in displaying the singular and complex distribution of the muscular fibres of the back part of the bladder.

A points out the fundus of the bladder.

B The lower part of the back part of the bladder.

And C the back part of the body of the bladder.

Fig. 2. Gives a representation of the ovarium, immediately after delivery.

Fig. 3. Represents a section of an ovarium, five months after delivery.

* See an account of this apparatus in Mr BENJAMEN BELL's System of Surgery, vol. v. p. 581, 6th Edition, Edinburgh 1796. It may be proper to add, that the very apparatus represented in Mr BELL's Plate 61. was used for two years, by a celebrated philosopher. without the slightest inconvenience. The whole of his urine passed through that canula. Upon dissection, a stone was found within the bladder, the prostate gland was enlarged, and nearly the whole of the urethra was obliterated.

Explanation of Plate IX.

Fig. I. Represents the inside of the bladder after the mucous membrane lining that organ had been removed.

Considerable pains have been taken to represent the distribution of the muscular fibres around the neck of the bladder, concerning which, anatomical authors have published very different descriptions. Some authors have affirmed, that no such muscle exists as a sphyncter of the neck of the bladder.

1. The aperture through which the urine passes.

The numbers 2. 2. are placed upon the trigone.

The numbers 3. 3. point out the strong muscular fibres of the bladder passing across it, behind the trigone.

Fig. 2. Represents a section of the ovarium of a girl of nine years of age.

Figs. 3. and 4. Represent an ovarium at the second month of pregnancy; fig. 3. represents the outer side, and fig. 4. a section of the ovarium *.

SECTION XI.

OF THE ORGANS OF GENERATION OF THE FEMALE.

IN treating of the Organs of Generation of the Female, it is proposed to describe them as they appear in a virgin in the meridian of life.

The female organs may be divided into the internal and external; the internal are, the Ovaria, Uterus, Fallopian Tubes, and Vagina; the external are the Mons Veneris, Labia Externa, Nymphæ, Clitoris, and Hymen.

* The drawings of the ovaria, from which the engravings were copied, were made forty years ago, by Mr T. DONALDSON.

TAB. IX.

To face Page 212. Vol. 2d

Fig. 1.

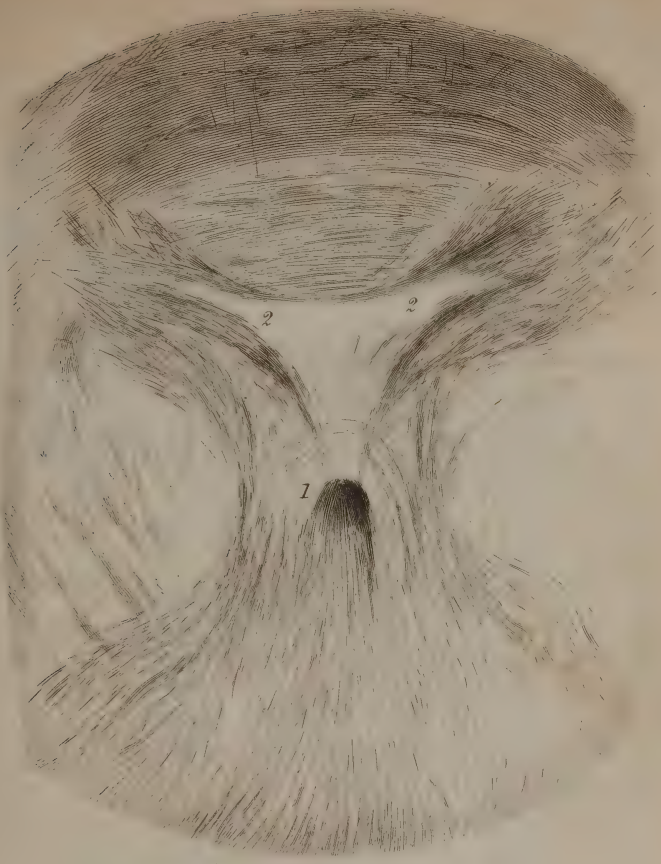


Fig. 3.

Fig. 2.

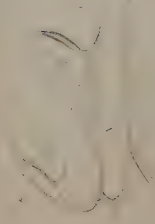


Fig. 4.

OF THE INTERNAL ORGANS OF GENERATION OF THE FEMALE.

The Ovaria, formerly called *Testes Muliebres*, constitute the most essential part of the female organs of generation; from these the rudiment of the fœtus is derived.

The ovaria are situated in the posterior pinions of the broad ligament of the womb; and, in prime of life, somewhat resemble in figure and size the testes of the male. They are about an inch, or an inch and a quarter long, about half an inch broad, and somewhat flattened at their sides; but, in old women they shrink materially in size, are to the touch considerably harder, and exhibit a very irregular or tuberculated surface, which is also sometimes the case with respect to the ovaria of women in the prime of life. Vide Plate VIII. Fig. 2. The ovaria of infants are of a reddish colour, and somewhat of a prismatic form. The ovaria are covered by the peritonæum; and when an ovum has passed into the uterine tube, HALLER always observed a fissure in that coat. Within the outer coat, the proper coat of the ovaria is placed; it is of a grey colour, and fibrous.

When the ovaria of young women are divided, they are found to be composed of a greyish substance, which has a spongy texture, in which a number of small transparent bodies called *ovula* may be observed.

BŒHMER has published the subjoined very full and accurate account of the structure of the ovaria *.

" Organa, quæ ova continent, *ovaria* dicuntur, et vi structuræ, corpora sunt utplurimum semiovalia, compacta, diversæ magnitudinis, fibroso-vasculosa, et glanduloso-vesiculosa, infra tubas, peritonæi membrana, quo involvuntur, hærentia, mediantibus alis vespertilionum tubis, ligamentis autem teretibus utero firmissime juncta."

" Ex structura ovariorum patet, *illa generandis ovis apta esse.* Ovaria enim corpora sunt fibroso-vasculosa, et glanduloso-vesiculosa (sect. 10); ejusmodi autem corpora organa

* Vide Obs. Anat. Halæ Magdeburg 1652.

constituunt secretoria (per princip. physiolog.); hinc etiam ovaria ad secretionem peculiaris liquidi apta sunt. Separatur autem in illis naturaliter lympha, ad ignem coagulabilis, diuersi coloris, plus minus diaphana, quæ *vel* in capsulis membranaceis, compressis, inæqualibus, in ovarii ambitu copiosis, et dimidia ut plurimum parte, per membranam ovarii transparentibus, altera vero firmius carni innixis; *vel* in sacculis fere sphæricis, a calicibus luteis, nucleorum instar comprehensis, continetur (per experient.) Sive igitur utraque corpuscula pro ovulis, sive priora pro vesiculis Graafianis, et posteriora pro ovis veris tantum habeas; utroque tamen casu ovaria generandis ovis apta, esse liquet.

" De capsulis membranaceis, quæ *vesiculæ Graafianæ* dicuntur, constat, *primum,* ' illas quavis fere ætate, longeque ante pubertatem quoad maximam partem in ovariorum superficie numerosas adparere, *sacculos vero membranaceos*, calicibus propriis inclusos, et undique ipsis nexos, non prius generari, quam fœmina pubertatis tempore ad venerem fervere incipiat, per series lente expediri, *substantia lutea* in ovaria corpus dicitur glanduloso-vesiculosum, structuræ capsularium renalium simile, ex lobulis frustulisque angulosis, inter se cohærentibus, ac varicosis propaginibus, lutei quandoque subcinerei coloris compositum; *calix* autem sive *nucleus* corporis lutei cavea appellatur.

" Dum corpus luteum, destructa successive vesicularum forma, turget, novum in illo generatur corpus Quicquid in illo subnascitur, sacculus est lympha coagulabili repletus; hic ovum dicitur. Ergo *ovum in substantia lutea generatur.*"

Sir E. Home has observed, " that the corpora lutea are the glands formed purposely for the production of ova,—that they exist previous to, and are unconnected with, sexual intercourse, and when they have fulfilled their office of forming ova, are afterwards removed by absorption equally whether the ova are impregnated or not *."

The corpora lutea are not equally conspicuous in all ani-

* Lectures on Comparative Anatomy, vol. iii. p. 304.

mals. They are large in the cow, but small in those animals that have several young at the same litter.

The corpora lutea are of an oval or circular form, and when divided, are found to be hollow in the centre, and to be of a yellowish-brown colour; and, according to the preceding observations, they exist before impregnation, and, indeed, previously to puberty, and are the nidus in which the ovum is formed.

These ovula vary much as to size: in general, they are about the bulk of a millet seed, or about 2 lines and a-half in diameter.

Different anatomists have published very opposite statements as to the number of ovula found in the ovaria. They differ, I believe, in different women, and even in the different ovaria of the same woman. But in the ovaria of old women there are no ovula, no yellow spots, or corpora lutea, as they have been called. These have been removed by absorption. Instead of ovula in old age, we meet with hard fibrous looking substances of a greyish colour, which are united to each other by a dense cellular substance.

The ovaria receive their blood from the spermatic arteries, which describe a tortuous course before entering these substances.

The nerves of the ovaria are derived from the renal plexuses.

It is a remarkable circumstance, that teeth and hair have sometimes been found in the ovaria of virgins.

Of the Uterus or Womb.

The womb is a hollow bowel, destined to receive the rudiment of the ovum from the ovaria, and to retain and nourish the fœtus, until it be capable of an independent existence.

The womb is placed between the bladder of urine and intestinum curvum; the broader part is directed backwards, and the neck forwards; it is loosely connected with the sides of the pelvis by ligaments and cellular substance.

In a few cases, two uteri have been found with corresponding vaginæ, or the womb has been divided by a longitudinal partition into two cavities. In a few cases, the womb has been

wanting; and I have seen it removed by a ligature without the loss of life.

Dr Granville has published an account in the Phil. Trans., of a case in which the ovarium and the Fallopian tube of one side were awanting.

The uterus is retained in its situation by *the broad ligament*, which is formed by a duplication of the peritonæum, and also by what have been called *the round ligaments*, which pass through the inguinal canals, and are lost in the groins.

These round ligaments have a fibrous structure, and are composed of arteries, veins, nerves and lymphatic vessels, all of which are united by cellular substance, and are involved in the peritonæum.

In some women there are canals formed by the peritonæum, which lie over the round ligaments, and into which the bowels sometimes descend.

These canals were first described by Nuck, in his Adenographia Curiosa, cap. 10., where he treats De Peritonæi Diverticulis.

Dr Camper found them open in 3 of 14 female children newly born; and Dr Wresberg, who has written a very learned dissertation on the subject, has observed, that he found these canals, which were large enough to admit a quill passing through the under abdominal aperture, to the groin or labium, in 19 out of 200 female children.

The womb varies in size in virgins, and still more so in women who have had children; and, after impregnation, it never returns to its original volume. Generally speaking, it is about 3 inches long, and about an inch and a half in breadth. In old age the womb becomes smaller and thinner in its parietes.

The womb, in figure, somewhat resembles a pear, flattened, and has been divided by anatomists into a *fundus*, or uppermost part, a *body*, a *neck* and *mouth*, or os tincæ, the long diameter of which is placed transversely.

Both its surfaces are somewhat convex, and more especially that next to the intestinum rectum.

The fundus is the broadest part of the uterus; and the

neck, which is the narrowest portion, bears resemblance in shape to a cylinder.

The womb feels hard on pressure, being of a compact texture, and composed of very small fibres, very intimately matted together.

The womb of a very fat woman has somewhat of a yellow hue, from the quantity of fat below the peritoneal coat of that organ.

In the section of the parietes of the womb, there is a grey substance, which has an appearance like cartilage, more especially at the neck of that organ, and which is intermixed with a reddish fibrous substance.

The muscular fibres of the womb, when enlarged by pregnancy, are very conspicuous; and it has been stated by Harvey, Veslingius and others, that it contracts many hours after death, and expels its contents *.

As the mouth of the womb is composed of denser materials, and is harder than any other part of this organ, it has been thought to resemble the mouth of the Tench fish and has been called Os Tincæ. The lips of the os tincæ of the virgin womb are in immediate contact; but those of women that have had several children are softer, more gaping, and not so accurately fitted to each other, and the neck of the womb is more rounded and thicker.

Immediately around the os tincæ there are a number of mucous glands, from which a gelatinous substance is derived, which fills up the mouth of the pregnant womb.

The cavity of the womb is nearly triangular, and bears but a small proportion to the external bulk of the organ, its parietes being very thick.

The uterine or Fallopian tubes, are affixed to the fundus uteri.

The uterus is lined by a very soft and very vascular mucous membrane. This, at the neck of the uterus, is tucked up into *rugæ*, which are disposed transversely; and by some have

* See the observations of my Father and Uncle on the Muscular Structure of the Womb, in the Edinburgh Physical and Literary Essays.

been described as being disposed in a foliated direction, like the leaves of the Palm tree; and, in the body of the womb, there are a few smaller rugæ, disposed in a longitudinal direction, in respect to the body of the womb.

Between the rugæ, there are several lacunæ, which secrete a mucous fluid.

These rugæ are more evident in the uterus of a child of two or three years old, as they are proportionally larger.

Walter of Berlin has described the nerves of the uterus as arising from the fourth hypogastric plexus, and also from the third sacral nerves.

Dr W. Hunter has described the nerves of the uterus as arising from the abdominal part of the sympathetic nerve, and from the hypogastric plexus.

According to Teidemann *, "Nervi, qui utero ovariis et tubis prospiciunt, e nervo sympathetico utriusque lateris originem ducunt, et sex plexus constituunt †."

Different opinions have been entertained as to the sensibility of the womb.

It has been stated, that the contact of the glans penis with the os tincæ, is the source of the pleasure women receive *in coitu;* but it has not been ascertained that the glans actually comes into contact with the os tincæ.

The uterus, when reduced to a morbid state, certainly acquires a larger share of sensibility.

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* Tab. Nervorum Uteri, p. 9., Heidelberg, 1822.

† Magnitudo ac copia nervorum uterum adeuntium diversis vitæ temporibus differt. Nervi in puellis *tenuissimi* sunt; in virginibus et feminis *majores et crassiores* observantur; denique in vetulis *minimi et tenerrimi* conspiciuntur. Massa, crassitudo, et copia nervorum uteri, dum fœtum fovet, augetur, uti Gulielmus Hunterus opinatus est; nam in tribus cadaveribus feminarum paulo post partum defunctarum, quæ secui, nervos uterinos *longe* majores vidi, quam in feminis non gravidis.

Cum nervi uteri, durante graviditate, majores fiant, nemo inficias ire potest, vim sentiendi hoc tempore auctam esse. Sensibilitati uteri tribuendum est, quod fœtus in utero motus sensu percipitur. Manum obstetricis infantem vertentis sentit. Dolores partum comitantes et sequentes, nasci videntur ex contractione fibrarum carnearum uteri, qua nervi hujus organi distrahuntur et comprimuntur.—Pages 10, and 11.

The uterus is largely supplied with arteries, veins, nerves, and lymphatic vessels.

The uterus is very largely supplied with blood, by the spermatic and uterine hypogastric arteries, the branches of which describe a tortuous course, and freely anastomose with each other.

The spermatic arteries arise, as in the male, from the fore part of the aorta, between the renal and inferior mesenteric arteries, or from the renal artery; they describe a tortuous course behind the peritonæum, are distributed upon the ovaria and fundus uteri, and anastomose repeatedly with the uterine hypogastric arteries, which are distributed chiefly upon the fundus uteri.

At the period of puberty, the female constitution undergoes a most remarkable change. To use the expressive language of Dr Harvey, "coloratior evadit, mammæ protuberunt, pulchrior vultus evadit, vox canora, incessus, gestus, sermo, omnia decora fiunt."

Before the menses appear, there is an increased determination of blood to the womb, in the same manner as the female quadruped comes in heat. The girl feels a sense of fulness in the region of the groin; hairs appear in the axillæ, and on the pubes; the mammæ swell out; the bones of the pelvis are expanded; and the womb, which had been somewhat rounded, assumes a pyramidal form; the vagina and mons veneris become larger, and the menses appear.

Before menstruation has been established, a whitish fluid is discharged from the vagina at irregular periods; the girl has a sense of uneasiness about the stomach and loins; and she frequently has nausea, vomiting, colicky pains, peculiar nervous sensations, and a strong pulse; and, after a short time, the menses suddenly appear.

In this country, menstruation generally occurs between the thirteenth and sixteenth years; but, with regard to the time, much depends on peculiarity of constitution, education, kind of life, and climate.

In Greece and Asia, the menses sometimes appear when the girl is only nine or ten years old; in Lapland, they do

not appear until the girl has reached her sixteenth or seventeenth year; and the menses are only in small quantity, and sometimes appear only in summer.

The quantity discharged is very various, even in women living in the same climate; generally speaking, in warm climates it is more abundant, amounting to 10 or 15 ounces; but, in Europe, not above half that quantity is discharged.

In tropical climates, the menses often cease when a woman has arrived at her thirtieth year; but, in this country, they continue until the woman is forty-five or fifty years old.

An opinion has prevailed, that unless a woman has menstruated she cannot be impregnated; but it is an opinion which is destitute of foundation.

It has been much disputed, whether the menses are derived from the vagina or uterus. I have seen the menses, in cases of prolapsus uteri, flowing from the vessels of the uterus; we then also observe the mucous membrane of the uterus softer than usual, covered with villi; and can also sometimes see open pores, from which blood is discharged.

Mr Brande has lately analysed the "menstruous discharge, collected from a woman with prolapsus uteri, and consequently perfectly free from admixture of other secretions. It had the properties of a very concentrated solution of the colouring matter of the blood in a diluted serum."

The veins of the virgin uterus are very numerous, and anastomose with the arteries.

The lymphatic vessels of the uterus follow the course of the spermatic and hypogastric bloodvessels.

The nerves of the uterus are derived from two small ganglia, placed behind the rectum.

Of the Uterine or Fallopian Tubes.

The uterine tubes, which extend transversely across the pelvis, and are connected with the lateral parts of the fundus uteri, and are about four inches long, form a communication between the ovaria and uterus. In form they are somewhat like to a trumpet, with the narrow extremities next to the uterus, the aperture in which is capable of receiving only a hog's

bristle, and at the larger opposite extremities, which are loose, there are a number of irregular processes called *Fimbriæ.* These tubes are covered by the peritonæum, within which, in young and robust women, there are muscular fibres disposed in a longitudinal direction, cellular substance, and a mucous membrane, which is continuous with that lining the womb, and which projects beyond the broader extremities of the Fallopian tubes, forming its fimbriated processes.

These tubes are largely supplied with bloodvessels. The veins proper to these tubes are larger than the arteries, and when animals have been opened *in coitu,* they have been observed much distended with blood, so that these fibres had a very dark colour; and the broader extremities of the tubes then embrace the ovaria.

Of the Vagina.

The Vagina, which forms the communication between the external organs and the womb, is a musculo-membranaceous canal placed between the bladder and intestinum rectum, which is partially covered by the peritonæum; that part next the womb is covered by the peritonæum, but that portion next the anus is uncovered.

The vagina is about seven inches long, in form nearly cylindrical, but somewhat flattened at its fore and back part. The anterior surface forms the same sweep as the bladder of urine and urethra, with which it is in immediate contact.

The vagina is much narrower in virgins than in women who have had children, for it never regains its former rugous appearance nor tone, and it is very distensible, curved, continued downwards and forwards, nearly in the course of the axis of the pelvis, and in virgins considerably wider above than below, and rather longer behind than before.

The vagina has two coats; it is lined by a mucous membrane, which is not of an uniform thickness in all women, and it is gathered into rugæ, which are large in virgins, but which are small in women that have had many children. This mucous membrane is rather of a redder colour near to the exter-

nal parts, and it has been described as forming anterior and posterior columns.

Between the rugæ there are numerous ducts, through which a mucous fluid is discharged. These ducts are large in some women, and have been by some authors called *Prostatæ muliebres;* in a few women there are slits on the surface of the mucous membrane of the vagina.

The outer coat is of a firm consistence; but in which the muscular fibres are not very obvious; notwithstanding which, it possesses, to a certain extent, a contractile power.

This coat is connected with the adjacent parts, by cellular substance, and the upper and back part of the vagina is covered by the peritonæum.

Of the Orifice of the Vagina.

The orifice of the vagina is about half an inch below the symphysis pubis, and surrounded and contracted by its corpus spongiosum, and its sphyncter muscle. Its aperture in virgins is very small, being contracted by the hymen, a semilunar-shaped membrane, the concave part of which looks upwards, and in the upper part of which there is an aperture, through which the menses are discharged.

The *sphyncter vaginæ* arises from the sphyncter ani. It surrounds the anterior part, and contracts the lower part of the vagina, and pressing upon the plexus retiformis of the vagina, is connected with the sphyncter ani: in some women it is a large and very distinct muscle; and is fixed into the crura clitoridis, where they are united to each other.

These veins are of very considerable size, and may be compressed by those muscular fibres which are said to form the *sphyncter vaginæ.* The vagina is largely supplied with bloodvessels.

The *transversalis perinæi* of the female is similar as to its origin with the corresponding muscles of the male: it is fixed into the sphyncter vaginæ, and sphyncter ani.

The orifice of the urethra is placed above that of the vagina, to which latter it adheres immediately.

The vagina has been found contracted, and also shorter

than usual. Mr Bryce informs me, that he once met with an instance in which the vagina was only two inches long, and ended in the blind sac. There was no uterus, for by passing the finger into the rectum, the bladder of urine could be plainly distinguished.

A contraction of the vagina is the effect of original malconformation, or of an adhesion, the consequence of difficult labour.

In some instances, the vagina is not of its usual length.

The vagina, though very rarely, has been divided by a partition extending from one end of it to the other, but more frequently a membrane has been observed to pass transversely across it, and this membrane is commonly placed behind the hymen.

OF THE EXTERNAL PARTS OF GENERATION.

The external parts are the Mons Veneris, Labia externa, Nymphæ, Clitoris, and opening into the vagina.

The labia externa, which are very prominent in fat women, are thicker above than below, and internally are lined by a mucous membrane, which in young women is of a red colour, but in old women of a purple colour. The labia externa are in contact with each other, excepting when the thighs are separated, and they cover, conceal, and defend the more internal and delicate parts. The labia externa are fixed by cellular substance to the symphysis pubis; they are somewhat of an oval form, and are in the adult covered by hair. The labia descend from the symphysis pubis, and are united about an inch from the anus by a transverse bridle, called *fourchette;* these have been named the *labia externa.*

The labia externa, when cut into, are found to be composed of thin cellular membrane, sebaceous glands, and fat; and their inner surfaces are lubricated by a quantity of sebaceous substance. Upon separating the labia externa from each other, a little rounded body, of a red colour, about one-eighth of an inch long, comes into view, which is in shape the miniature of the male penis, and which, like it, is covered by a

fore-skin, or prepuce, under which there are glandulæ odoríferæ; this is the *clitoris*. The clitoris not only resembles the penis in appearance, but also in structure; it is made up of two penes.

The clitoris, as to its structure, is in all respects similar to the penis of the male, excepting in being unconnected with the urethra.

It has its proper suspensory ligament; has the same kind of investing membrane; has its glans; is composed of two crura, which take their origin from the ossa ischia; it has its proper frænum; the crura clitoridis are covered by their erector muscles, which arise from the ossa ischia, and are fixed into the body of the clitoris; internally it consists chiefly of a plexus of tortuous veins; and lastly, like the penis, it is distended *in coitu*.

The clitoris sometimes attains an extraordinary size, and when a source of inconvenience, may be extirpated, which, according to Bruce and Brown *, is a religious ceremony.

Of the Labia Interna.

The Labia Interna, or Nymphæ, are placed on each side of the vagina; they descend from the frænum of the clitoris.

The labia interna, or nymphæ, are spongy bodies, which are in young women of a pale red or purplish colour, and descend from the frænum clitoridis on each side of the orifice of the vagina.

The nymphæ are thin and flattened, and rather broader in the middle than at either extremity, or somewhat in form like the labia externa.

They are generally fully covered by the labia externa, unless when these are separated.

The nymphæ possess a considerable share of sensibility.

The nymphæ are generally, in European women, about an inch long, but in warmer climates are sometimes much longer and broader, and project beyond the labia externa; in the

* See their Travels in Africa, Egypt, and Syria.

Hottentots and Bosjesman females they sometimes equal four or five inches in length.

This elongation proves a source of great inconvenience; and, according to NIEBUHR *, has led to the practice of cutting off the greater part of it.

I received some time ago, from a friend, a drawing of the nymphæ of a female Hottentot, which was made by that excellent artist Mr DANIEL, during his residence at the Cape of Good Hope, from which it is evident, that the description given of those by VAILLANT, who considers them to be elongations of the labia externa, is quite incorrect. Mr BARROW † and Dr SOMMERVILLE ‡ bear testimony to the above fact; and, according to these authors, the great size of the nymphæ is congenite, and they are of an extraordinary size even in the children of the *Bosjesman.*

The large nymphæ of the female who shewed herself in London, Edinburgh and Paris, under the name of the Hottentot Venus, who, to use the phrase of CUVIER, had "la complaisance de se depouiller," were not seen during her life, for "elle tint son tablier (enlarged nymphæ) soigneusement caché, soit entre ses cuisses, soit plus profondément, et ce n'est qu'après sa mort qu'on a su qu'elle le possedoit."

The other external parts of generation of the female Hottentot do not bear a proportional size to the nymphæ, for the mons veneris and labia are smaller than in most European women, which was most distinctly shewn by Mr DANIEL in his drawing, and is confirmed by the observations of that acute observer Dr SOMMERVILLE.

This uncommon size of the nymphæ is not peculiar to the natives of Southern Africa; it exists among the Moors § and Copts, who, to get rid of the inconvenience, perform circumcision on the girls.

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* Vide Travels, vol, ii. p. 250.

† Vide Travels into the Interior of Africa.

‡ Vide Medico-Chir. Trans, vol. vii.

§ Vide BRUCE's Travels.

The nymphæ consist of cellular substance, sebaceous glands, and bloodvessels, serpentine small branches of the pudic artery, and corresponding veins, inclosed within a duplicature of skin.

On separating the nymphæ, an orifice presents itself about an inch below these, viz. *the orifice of the urethra;* and, immediately under it, the orifice of the *vagina* is placed, which in a virgin is surrounded by the membrane called *Hymen*, which is a thin membrane of a circular or semilunar form.

There is great variety as to the thickness and form of the hymen in different women: sometimes it is imperforated, in consequence of which the menses are retained behind it; or it is bifid, or trifid.

The hymen has been stated to be peculiar to the human race; but according to CUVIER, it exists in some quadrupeds.

The existence of the hymen has been considered as a test of virginity; it is ruptured in the first act of coition, and the remnants of it have been called *Processus myrtiformes.*

The hymen is sometimes so thick that it cannot be ruptured, and prevents intercourse between the sexes, and is, at the same time, imperforated: hence the menses are retained behind it, which gives rise to a considerable tumour.

Below the orifice of the vagina, and between it and the transverse fold of skin, by which the lower part of the labia externa are united, there is a small cavity, somewhat in figure like a boat, which hence has been called the *fossa navicularis.*

The external organs of generation of the female are supplied with blood by the branches of the pudic artery.

The nerves of these organs are derived from the pudic nerves.

The lymphatic vessels of the external female organs of generation pass into the lymphatic glands of the groin; and those at the sides of the pelvis pass into the iliac, and then into the lumbar lymphatic glands.

In old age, the mons veneris is much less prominent; a great part of the hair falls off, and what remains is grey and straight.

The labia externa and nymphæ become smaller, softer, and more flaccid.

At so early a period of life as the second or third year, the organs of generation are proportionally larger than most of the other parts of the human frame. The mons veneris is then apparent; the labiæ are well formed; the nymphæ are long; and the clitoris of a large size,—sometimes, indeed, of so large a size as to lead to a mistake as to the sex.

The vagina is proportionally longer than after puberty, and the rugæ upon it are very distinct and beautiful. The uterus is also large, but not exactly of the same form as that of the adult; the neck of it is proportionally larger and rounder than that of the adult.

Of the Relative Situation and Connection of the Female Organs of Generation.

The lateral view of the pelvis is the most favourable for exhibiting the relative situation and connection of the contents of the female pelvis.

The upper and back part of the bladder is covered by the peritonæum, which is reflected upon the back part of the vagina, the cervix and the fundus uteri. It then descends and covers the posterior part of the uterus, which therefore is included in a doubling of the peritonæum, which forms what has been called *The Broad Ligament of the Womb.*

From the womb, the peritonæum passes to the rectum and os sacrum; thus the womb may be readily expanded, and ascend into the abdomen.

From the preceding description of the course of the peritonæum, it follows, that the anterior of the body and neck of the womb are not invested by the peritonæum, but are in immediate contact with the bladder of urine.

The tubes connected with the fundus uteri, called *Fallopian* or *Uterine*, the ovaria, the bloodvessels and nerves, and round ligament of the womb, are also included within the upper part of the duplication of the peritonæum, called Broad Ligament.

The anterior layer of the broad ligament is inserted into the sides of the pelvis, which is thereby divided into an anterior and posterior chamber, and is then continued to the side of the bladder. In the anterior chamber, the bladder of urine is lodged; in the posterior, the intestinum curvum; and the posterior layer of the broad ligament is continued to the intestinum rectum.

The broad ligament is subdivided into an anterior and posterior part; in the former of which the Fallopian tubes are lodged; in the latter, the ovaria, and their ligaments. Owing to relaxation and weakness of the parts with which the uterus is connected, it sometimes falls lower down than usual into the vagina, or even between the labia pudendi, constituting the disease called *Prolapsus Uteri.*

The fundus uteri is sometimes turned backwards and downwards upon its neck, between the vagina and rectum, and its mouth is directed forwards. This has been called *Retroversion of the Womb.*

Levret has described the *antiversion of the womb* in this state: the fundus is thrown forwards, and the mouth is directed to the sacrum; and thus the neck of the bladder is compressed.

The uterus is also occasionally turned inside out. It falls through the os tincæ, and protrudes externally. In this case the vagina is also inverted, and forms a neck for the tumour, which has somewhat of a pyriform shape.

In this lateral view, the vagina is seen in its situation between the rectum and bladder, to the under surface of which it is connected by cellular substance. It forms a crooked canal, which is very nearly in the axis of the outlet and cavity of the pelvis; and the plexus of veins which covers the front of the vagina is also conspicuous.

When the vagina has been opened, it is found to be somewhat flattened: it is wider above than below, and it is fixed to the os tincæ higher behind than before: hence the back-part of the womb is more evident to the touch than the anterior.

SECTION XII.

ON GENERATION.

As animals are destined to live but for a certain period, it is necessary that they should possess the power of procreation.

The period at which animals are capable of procreation is very various, depending upon the species, climate, food, &c. Generally speaking, those of warmer climates sooner arrive at the period of puberty than those of the more temperate climates.

But little is known respecting the function of generation. In the vegetable as well as in the animal kingdom, the young is attached, by some means, to the parent; and the separation of the one from the other is the birth; or generation consists in the appearance of an organized fœtus in or upon some part of a larger animal, from which it is separated, at a certain period, to take on an independent existence.

Individuals amongst neat cattle, in which the male and female organs are to a certain degree combined, have been called *Free Martins*; and it is worthy of remark, that in these, according to Mr Hunter, the ovaria and testes are imperfect.

Human hermaphrodites have been described by Haller, Petit, and others.

The clitoris has been so much elongated, as to resemble the penis of the male: sometimes it has been an inch or more long, and thick in proportion; and, on the other hand, malconformation of the external organs of the male may lead to the suspicion of the person being a hermaphrodite.

I had occasion to be consulted, along with Mr Bryce and Dr Clarkson, by a lad, who, at first sight, might have passed for a hermaphrodite; there was no part of the penis, but the glans, and it passed between two bodies, very similar in size, situation and form, to the labia externa, and internally they were of a red colour, and had a villous surface.

There was a distinct groove on the upper surface of the glans, along which I passed a female catheter into the bladder. The neck of the bladder opposed but a slight resistance to the passage of the instrument; and there was a fissure between the testes.

In the class Mammalia, the semen is introduced, by the penis of the male, into the vagina during copulation; thus the ova are impregnated within the body of the female; and the fœtus is not discharged until it is capable of an independent existence.

The ovarium is the most essential part of the female organs to generation; from it the rudiment of the fœtus is derived.

This is obvious, from the difference in the structure of the ovarium of a virgin, and that of a woman who has had children; and from the effects upon the female constitution, resulting from the extirpation of the ovaria. Menstruation ceases, the mammæ become less prominent, the muscles become larger, and more like those of the male. The whole form of the body is altered, and becomes somewhat like to that of a man *.

The uterine tubes, from their peculiar form, situation and structure, are well calculated for giving passage to the contents of the ovarium, and for conveying these into the womb; and the obstruction of these tubes leads to barrenness.

The testes form the most important parts of the male organs; they secrete the semen, which is probably propelled, through its circuitous rout, by a muscular power, (though the muscular fibres of these ducts are so small as to escape our unassisted sight); it is carried to the vesiculæ seminales, within which it is collected, till it is required.

There are various causes which destroy the power of procreation on the part of the female; the unnatural size of the labia externa, clitoris, or nymphæ, the induration of the hymen, so that it remains entire; diseases of the uterus, ovaria,

* Vide case by Mr P. Pott, and also by Mr Pears, Phil. Trans. for 1805: a woman was born without ovaria; this person was broad-shouldered like a man, she never menstruated; and there were no signs of puberty.

or obstruction of the uterine tubes, or the vagina, or that canal being too short.

The imperfect formation, or diseased state of the testes, the semen being in a morbid state, a wrong direction of the orifice of the urethra, the adhesion of the prepuce to the frænum, or debility from too frequent emissions of semen, occasion sterility on the part of the male.

Lastly, it has been matter of much dispute, whether the fœtus be derived from the mother *, from the father †, or from both parents ‡.

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* Steno. In De Graaf, de Mulier. org.

Harvey. De Conceptione.

Haller. Sur la Formation de Cœur.

† Aristotle, De Generatione Animalium, lib. i. cap. xix. xx. et sequentibus.

Galen. In Operum Epitome, De Semine, lib. i.

Leeuenhoecius. In operum ejus, tom. ii. "De Ovario, et imaginariis ejus ovis; homo ex animalculis oritur," &c.

Hartzocher. Recueil de Plusieurs Pièces de Physique, p. 191.

Boerhaavius. Impetum Faciens, cap. secund.

‡ Hippocrates. De Genitura.

Lucretius. In Lin. 1822, lib. iv. et in aliis locis; also, Mason Good's Translation.

Buffon. Natural History, translated, vol. ii.

Maupertuis. Oeuvres, tom. ii. Venus Physique, chap. viii.

Needham. Account of some New Microscopical Discoveries. Phil. Trans. vol. xlv. p. 615.

Hunter. On the Animal Economy, &c.

Blumenbach's Physiology, translated by Elliotson.

Haighton. Phil. Trans 1797, p. 159.

Explanation of Plate X.

Having described the bowels of the chest, abdomen, and pelvis in the adult and in the fœtus, in order to convey a distinct idea of these in the fœtus, I got Mr W. Lizars to make an accurate drawing of them, pointing out all their peculiarities.

That the relative size and situation of the different bowels may be more obvious, the engraving is of the size of nature, and was copied from a fœtus between the seventh and eighth month.

A represents the Lungs.

B the Thymus Gland.

C the Heart.

D the Diaphragm, which is much flatter than in the adult.

E the Liver, divided into its two great lobes, which differ but little from each other in size.

F the Bloodvessels passing from the Navel to the Fossa Umbilicalis of the Liver.

G the Omentum Majus.

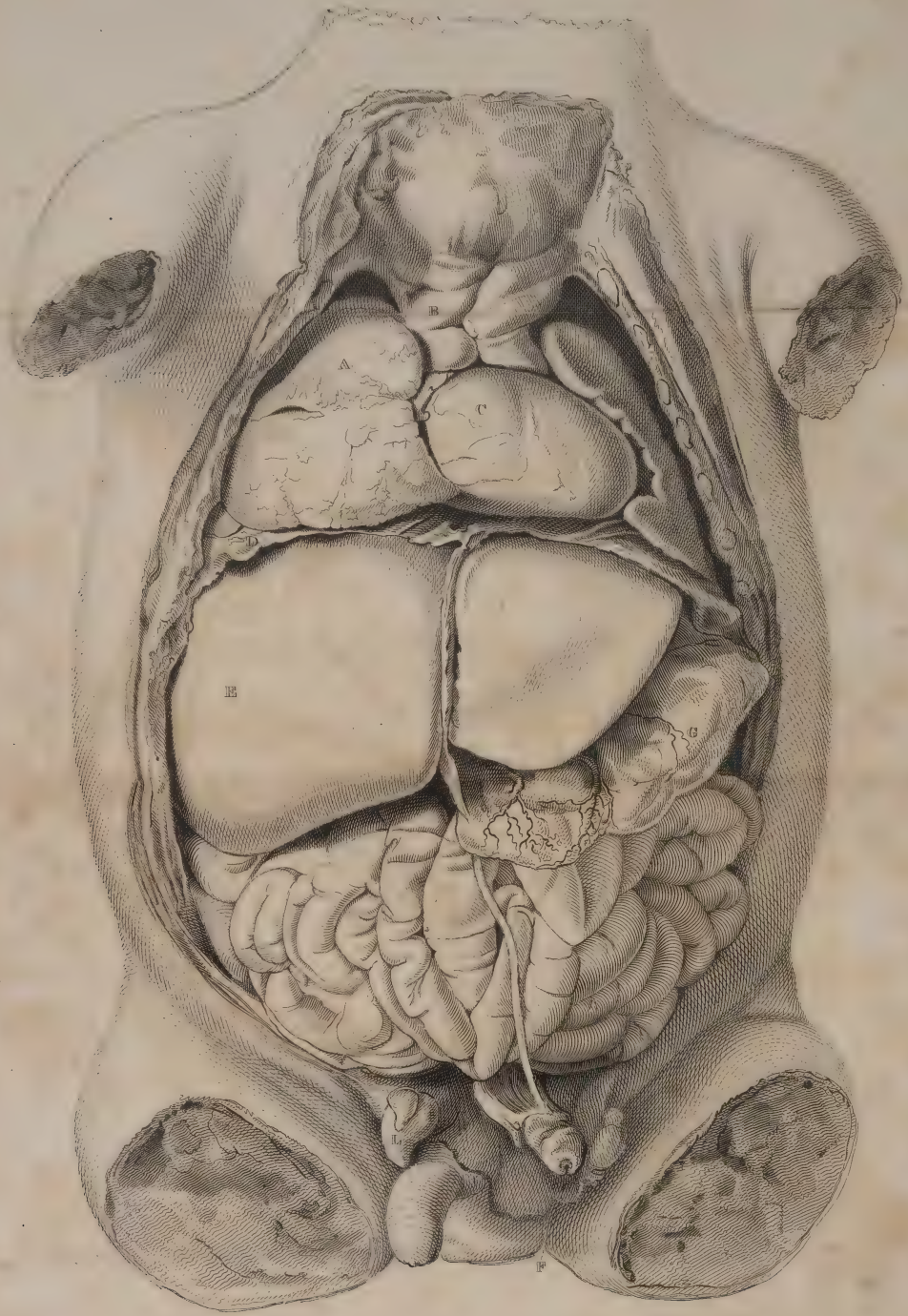
H the several turns of the Intestines.

I the Scrotum.

K the Penis.

L the Testis of the right side.

PLATE X.



Engraved by W.H.Lizars

CHAPTER V.

OF THE DISTRIBUTION OF THE ARTERIES AND VEINS.

HAVING, in a former Chapter, described the structure of the coats of the arteries and veins, and all those general circumstances regarding these, which are most worthy of attention, I shall now proceed to describe their particular distribution.

In conducting the reader through this department of anatomy, I shall describe those larger branches which are important, in a practical point of view, from their being exposed to disease, and to be cut or torn; or from their forming collateral anastomoses, by which the life of a part is preserved, when the main trunk has been obstructed.

But, were I to proceed further, and attempt to describe the more minute branches, I might be accused of being most tediously and most uselessly minute; beside, such minute ramifications do not, in any two individuals, follow the same course. Nor do I intend, from books, to draw up an account of all the varieties which have occurred, as to the origin and course of the arteries. All I shall aim at is, to describe those varieties which are most important, in a practical point of view, and such as have fallen under my own notice.

Every deviation from the usual distribution of the common or external carotid, subclavian, humeral, and femoral arteries, merits attention, as the organs on which these arteries are distributed are frequently the subjects of chirurgical operations, as well as the arteries themselves.

All the arteries of the body take their rise from the Pulmonary Artery and Aorta.

The origin of the *Pulmonary Artery*, and its course, have been already described *.

This artery divides into two great branches, called *right* and *left*, as they are distributed upon the right and left lungs. They are unequal in size and length, the former being the larger, and also the longer.

These branches are subdivided into a number of very small branches, which are distributed along with the smaller branches of the air-tubes; and they ultimately form a *net-work* upon the air-cells of the lungs.

These arteries freely communicate with the bronchiæ.

The pulmonary artery is by no means so liable to disease as the aorta; and though it is included in the same sheath, I have never seen a communication established between these, by disease.

An aneurism, in the front of the aorta, bears a strong resemblance to that of the pulmonary artery.

Of the Pulmonary Veins.

The *Pulmonary Veins* differ from those of other parts of the body, in being smaller than those of the corresponding artery.

The pulmonary veins follow the same course as the arteries: but are rather smaller; and at length are united into *four pulmonary veins*, which terminate in the posterior auricle of the heart.

Of the Aorta.

The origin of the aorta, from the posterior ventricle of the heart, has been already described. This artery is placed behind the pulmonary artery, and is connected with it by the serous membrane of the pericardium.

This great artery, immediately after its exit from the heart, is somewhat expanded, and about two inches of it are contained within the pericardium.

The aorta arises from behind the pulmonary artery, and

* Vide Page 37. of this Volume.

passes upwards, in the direction of the axis of the heart, to the right side, as high as the cartilage of the second rib, and then is directed backwards, almost horizontally, to the left side; thus forming what has been called the *arch of that artery*, which terminates opposite to the third dorsal vertebra, on the left side of the body.

The relative situation of the aorta, in respect to the neighbouring parts, merits attention, as tending to explain the effects and consequences of aneurism of certain parts of that great artery.

1*st*, That part of the aorta which is contained within the pericardium sometimes bursts *.

2*d*, The uppermost part of the arch of the aorta presses upon the cartilages of the second and third ribs of the right side, and on the uppermost portion of the breast-bone, and sometimes occasions their absorption; thus the tumour, which was originally internal, becomes external. A very large aneurism of the aorta ascends into the neck, considerably above the collar-bone.

3*d*, The aorta, when enlarged, presses much upon the left branch of the windpipe, creating constant cough, difficult breathing, and great oppression, and, by the blood from it bursting into that tube, proves fatal.

4*th*, Or the enlarged aorta bursts into the left pleura or gullet.

5*th*, If the aneurism of the aorta be seated near to the vertebræ of the back, the patient suffers acute pain in the back, and often palsy in the limbs; and, after death, one or more of the vertebræ are found carious; and sometimes the tumour protrudes at the side of the spine.

6*th*, The enlarged aorta, pressing upon the vena innominata, explains the cause of the purple colour of the countenance of persons afflicted by that disease.

Of the Coronary Arteries.

These two arteries take their rise immediately behind the

* Vide Plate II.

semilunar valves of the aorta; they are nearly equal in size, and have been called, from their position, *Anterior* and *Posterior*, or *right* and *left*.

The *right* or *anterior*, or larger, runs between the right auricle and ventricle; it usually divides into three branches.

The superior runs in the groove between the auricle and ventricle, and supplies the base of the heart, and anastomoses with the left posterior coronary. The second branch passes along the thin edge of the heart to the apex of it; and the third, the largest branch, fills the groove in the inferior surface.

The *left coronary artery* passes between the left auricle and ventricle, and is subdivided into anterior and posterior branches, which are distributed upon the base, and upon the left side of the heart, and a branch along the septum to the point of the heart.

This artery anastomoses with small branches of the internal mammary, and phrenic arteries.

I have sometimes seen the coat of these arteries partially converted into bone, in the bodies of persons who have died from the disorder called *Angina Pectoris*.

SECTION I.

OF THE ARTERIES WHICH ARISE FROM THE ARCH OF THE AORTA.

THREE large trunks commonly arise from the arch of the aorta, the ARTERIA INNOMINATA, common to the right carotid and right subclavian arteries, and the *left carotid and left subclavian*, which are separate trunks.

But sometimes there are only two trunks from the arch; and sometimes four; viz. a right subclavian and right carotid, and a left subclavian and left carotid.

The *Arteria Innominata* is not of an uniform length and size. It lies over the windpipe, and is covered at its rise by the vena innominata, by the sterno-hyoid and sterno-thyroid muscles, and the uppermost piece of the breast-bone.

Of the Arteries of the Head and some of those of the Neck.

There are four arteries which supply the head and neck, viz. the carotid and vertebral arteries, which frequently and freely communicate with each other, so that the functions of the brain may be continued, though one of the carotid arteries be obstructed, and though the vertebral arteries be awanting. Such a case occurred to that excellent anatomist the late Mr Wilson of London, where the patient had not suffered from any disorder as to the functions of the brain.

The Common Carotid Arteries are of considerable size, and may readily be exposed by making a cut on the inner edge of the sterno-cleido muscle, and by drawing them towards the windpipe, the sterno-hyoid, and sterno-thyroid muscles; thus a chain of conglobate glands comes into view, and, by removing these, a tendinous sheath is exposed, in the front of which that nerve called the *descendens noni* is placed.

This sheath contains the common carotid artery, the internal jugular vein, and the par vagum of the eighth pair of nerves, which lies between the artery and the vein.

It may be observed, that the common carotid arteries frequently communicate a pulsation to the conglobate glands which lie over it, which has sometimes led the surgeon to suppose his patient afflicted by aneurism of the carotid artery; but on pulling to a side the glands, the pulsation ceases.

The common carotids ascend in the neck, between the internal jugular vein and the windpipe.

There is a slight difference as to the size of the common carotid arteries. The right is rather the larger. At the lower part of the neck the space between the common carotid arteries is much less than in the upper part of the neck, where the pharynx, windpipe, and gullet intervene.

The right carotid in its ascent covers the sympathetic and recurrent nerves, the longus colli and rectus capitis anticus major muscles.

The common carotid artery generally divides, nearly on a level with the larynx, into two branches: as one of these is proper to the internal, and the other to the external parts,

the former has been called *the internal*, the latter, *the external carotid*. But the place of the division is by no means uniform. I have a preparation, in which it takes place near to the bottom of the neck.

The common carotid artery sometimes divides opposite to the fourth or fifth cervical vertebra, into the external and internal carotids. In some cases (as in a specimen I saw in the museum of Mr A. Burns of Glasgow,) the common carotid, instead of dividing into two great branches, divides into a number of small branches.

Mr Burns shewed me another preparation, in which the carotid artery, opposite to the styloid process, divided into two large arteries, the internal carotid, and a trunk, which was common to the temporal and maxillary arteries; and there were several branches sent off instead of the external carotid.

These varieties as to the origin of the external and internal carotids, should be borne in mind by the surgeon who is about to perform the operation of carotid aneurism.

Mr A. Burns has pointed out very ably the relative situation of these arteries to the under-jaw, when the head is carried in the usual manner, or when it has been thrown backwards *, and also the difference as to the relative position of the carotid artery and angle of the under-jaw in the young and old subject: in the latter, when the teeth have fallen out, the distance between the angle of the jaw and the division of the common carotid artery is greater than whilst the teeth remain.

Aneurism of the carotid artery is not rare. The symptoms of the disease may be readily explained from the parts in the neighbourhood, which are compressed by the aneurism, viz. the difficult breathing from pressure on the windpipe; difficult swallowing, from pressure on the gullet; the headache, from pressure on the internal jugular vein impeding the return of blood from the head.

Sir A. Cooper thus describes his mode of operating: "I

* Vide first volume of this work, art. Os Hyoides.

began my incision opposite the middle of the thyroid cartilage, from the base of the tumour, and extended it to within an inch of the clavicle on the inner side of the sterno-mastoid muscle. On raising the margin of this muscle, the omo-hyoideus could be distinctly seen crossing the sheath of the vessels, and the nervus descendens noni was also exposed. I next separated the mastoid from the omo-hyoideus muscle, and the jugular vein became apparent, which being distended at every expiration, spread itself over the artery. Drawing aside the vein the par vagum was evident, lying between it and the carotid artery, but a little to its outer side. This nerve was easily avoided: a blunt iron probe, constructed for the purpose, was then passed under the artery, carrying a double ligature with it. Two ligatures being thus conveyed under the artery, the lower was immediately tied. I next detached the artery from the surrounding parts to the extent of an inch above the lower ligature, and then tied the upper. Lastly, a needle and thread were passed through the artery above one ligature and below the other. The division of the artery was then performed."

SECTION II.

OF THE EXTERNAL CAROTID ARTERY AND ITS BRANCHES.

The External Carotid Artery ascends upwards, nearly in a line parallel to the ascending process of the lower jaw, and is placed about half way between the zygomatic process of the temporal bone and the angle of the under-jaw.

It passes behind the posterior belly of the digastric muscle and the stylo-hyoid, taking protection from the angle of the under jaw-bone.

The first branch, called *Superior Thyroid*, comes off at the place of division of the common carotid, and descends, following a tortuous course to the upper part, or sometimes near to the middle, of the thyroid gland: it then suddenly divides into branches, which are distributed upon the sterno-mastoid

and platysma-myoides muscles, and upon the muscles which are fixed to the os hyoides, larynx, and the membrane of the larynx.

The trunk of the artery always communicates with the corresponding artery of the opposite side, and also with the inferior thyroid artery, a branch of the subclavian artery. A considerable branch of this artery enters the larynx between the thyroid cartilage and os hyoides, or sometimes it passes through the thyroid cartilage, and then divides into small branches, which are spent upon the membrane of the epiglottis, and arytenoid muscles.

Within these few years, several cases have been published, in which that very dangerous operation, the extirpation of the thyroid gland, has been performed,

I subjoin the history of one of the operations as performed by Hedenus of Berlin; who informs us he had operated successfully six times.

" I then divided the skin in a longitudinal direction, with a convex-edged bistoury, from the os hyoides to the top of the sternum: not being able by this means to form any flap, I dissected back the skin and platysma myoides on both sides from above down, so as to form a flap of two inches, and turned back on either side. I then saw the sterno-hyoid and sterno-thyroid muscles, much increased in size, and firmly fixed to the whole tumour, and destitute of the usual aponeuroses: these I endeavoured, for the sake of sparing them in the operation, to dissect and separate from the swelling. Scarcely had I dissected away a quarter of an inch, when blood streamed in great quantity from numerous small arteries, which could neither be tied, on account of their minuteness, nor restrained by any styptic application, since their mouths were retracted and hid beneath the strong and firm aponeurosis which invested the tumour, so that they could not be reached or withdrawn. I gave up, therefore, the attempt to separate these muscles, and came immediately to the resolution of cutting them through at their points of attachment above and below, and removing the included portions with the tumour. I next (continues our author,) separated the

swelling above and below, from the sterno-cleido-mastoid and omo-hyoid muscles, as also from the jugular veins and carotid arteries, which were intimately connected vith the tumour by cellular membranes, until I freed them, as far as the point where the thyroid arteries come off. I then tied both the superior and inferior thyroideal arteries of either side, close to the tumour, and, on account of the free anastomoses, used the double ligature, dividing the vessels in the space between. The deeper I carried my dissection now, the more serious did the operation appear, since at every cut of four or five lines, I was obliged to tie two or three arteries; and these ligatures, on account of the size of the tumour, and the deep situation of the vessels, were very difficult, and required great care.

" When I had, with the greatest caution, dissected to the base of the tumour, which was firmly fixed to the thyroid cartilage and the three upper rings of the trachea, on every side so great a number of arteries presented themselves, for the most part of the diameter of the radial or digital arteries, that I could not cut a line or two without dividing two or three of them. Under these circumstances, and as the patient, notwithstanding the speedy ligature of the arteries, (effected partly by means of the artery forceps, partly by the needle and thread,) had already lost a very considerable quantity of blood, I hesitated not, that I might bring the operation to a more speedy close, and spare as much as possible the loss of blood, to adopt at once the method since recommended by Brunninghausen,—namely, to tie the base of the swelling, and then, with the bistoury, to extirpate the tumour above it. I used for this purpose a blunt-pointed aneurismal needle, armed with two four-threaded ligatures; and while I directed the tumour to be pulled upward, passed the needle through the middle of its base, and, drawing the ligatures through, I tied one below, the other above, as firmly as possible. However, that I might perfectly command the bleeding, I passed also a third ligature around the whole circumference of the swelling, and extirpated the tumour now without any bleeding from the

parts included in the ligature. I now cleaned the wound from blood with a sponge, that I might see if any important vessel was yet bleeding; and as this was not the case, there being only an oozing from the small vessels of the wounded surface, I placed the ligatures over the lips of the wound, and fastened them there by means of plaster. I sprinkled the whole wounded surface with powdered gum arabic, and laid on this agaric wet with THEDEN'S vulnerary water, and, filling the remaining cavity of the wound with charpee, I brought the lips of the wound as much as possible together by adhesive plaster; over the plaster I laid dossils of lint and compresses wet with vinegar, which were renewed every six or eight minutes; and the whole secured by a bandage."

The next considerable branch is the LINGUAL. This artery, at its root, is in contact with the lingual nerve; it reaches the junction of the body with the lateral portion of the os hyoides; it is covered only by the platysma-myoides; it passes over the corner of the os hyoides, and then under the hyoglossus and genio-glossus muscles to the tongue. At the anterior margin of the hyoglossus muscle, this artery divides into several *small branches*, viz. a *branch* to the constrictor medius of the pharynx; a *branch* to the hyoglossus and mylo-hyoideus muscles, and a *branch*, called *dorsalis linguæ*, passes outwards and upwards, near to the insertion of the stylo-glossus muscle. This artery frequently anastomoses with the corresponding artery of the opposite side, which passes under the middle of the tongue to its point: a branch of this artery is sent between the sublingual glands to the genio-hyoid and mylo-hyoid muscles.

3. The PHARYNGEAL ARTERY arises a little above the lingual, from the back part of the trunk of the carotid; and, dividing into *small branches*, supplies the pharynx and fauces with blood. It enters the skull at the foramen jugulare, and gives branches to the dura mater, the external membrane of the brain.

4. The next branch, which is smaller than the preceding, is called the ASCENDING PALATINE. It is covered by the styloid muscle, and is distributed upon the side of the pha-

rynx, upon the tonsils, tongue, palate, and inferior maxillary gland. Small branches are also sent to the stylo-hyoid, stylo-pharyngeus, and hyoglossus muscles.

5. The continuation of the carotid artery, before passing under the stylo-hyoid muscle, and posterior belly of the digastric muscle, gives off small branches to the pterygoid muscles; then it ascends, following a tortuous course in a groove of the submaxillary gland, and passes over the under jaw-bone, about an inch from the angle of the lower jaw, at the fore-part of the masseter muscle; and hence has been called the ANGULAR, FACIAL, or EXTERNAL MAXILLARY ARTERY. The trunk of the artery then passes obliquely upwards and inwards, describing a tortuous course to the side of the mouth and nose, sending off, in that course, a great many branches, which are distributed upon the muscles of the face. It ascends to the internal canthus of the eye, where it anastomoses repeatedly with the branches of the ocular and frontal arteries. A large branch of this artery has been called ORBICULAR, or the INFERIOR LABIAL, as it is distributed upon the under lip. It passes over and supplies the depressor labii inferioris and orbicularis oris, and anastomoses with the corresponding artery, and also with the superior labial artery.

The *orbicular arteries* of the lips are, in some cases, of very different sizes. I have seen the orbicular arteries of the lips derived from the transverse facial artery, which was of an unusual size, and as large as the angular artery of the face. In such cases, the angular artery is not above half the common size, and it divides into a number of small branches, which are distributed upon the muscles of the lip, the branches of the transverse artery of the face supplying the side of the nose with blood, and the muscles connected with the upper jaw.

The SUPERIOR LABIAL ARTERY is next sent off. It is placed under the greater zygomatic muscle and sphincter oris. It follows a tortuous course, and sends upwards several small branches, which supply the cartilages at the extremity of the nose; and there are two or three small branches of this artery

which communicate with the branch of the intermaxillary, which comes out at the foramen infra-orbitarium.

The labial arteries are often much enlarged in the disease called *Aneurism*, by anastomoses, and pulsate violently whenever the circulation of the blood is accelerated.

When it is necessary to cut out a portion of the lip, on account of cancer, or to perform the operation for the cure of a hare-lip, it is useful to compress the angular artery against the under jaw; as thus the flow of blood may be checked during the operation.

A branch called *posterior artery of the ear*, is derived from the external carotid: in its course through the substance of the parotid gland, it is spent on the back part of the ear.

7. The OCCIPITAL is a large branch of the external carotid. It is covered by the digastric muscle at its origin. It passes across the jugular vein, and between the mastoid process and first vertebra of the neck; in which course it is covered by the posterior part of the digastric trachelo-mastoid, splenius, and complexus muscles, and at length, becoming subcutaneous, subdivides into many branches, which are distributed upon the middle of the back part of the head, and which anastomose with those of the posterior branch of the temporal artery. This artery also gives off branches to the digastric muscle, to the cervical glands, and anastomoses with the thyroid artery.

A branch of this artery, called *auricular*, supplies the lobe of the ear, the parotid gland, and upper part of the sterno-mastoid muscle.

A branch of this artery passes downwards, and is distributed upon the trachelo-mastoid muscle, and the other adjacent muscles.

8. The TRANSVERSE ARTERY of the face is derived from the external carotid, within the substance of the parotid gland, before it sends off the temporal and intermaxillary arteries. This artery passes through the anterior margin of the parotid gland, ascends somewhat over the masseter muscle, passes under the levator anguli oris, and zygomatic muscles, and anastomoses with the branches of the angular artery.

In some cases, there is a larger and a smaller transverse artery of the face. The smaller gives branches to the small salivary gland which lies along the duct of the larger parotid gland. It sometimes happens, that the transverse artery supplies those parts of the face which usually receive their blood from the branches of the angular artery; in that case, it is a vessel of considerable size.

9. The EXTERNAL OR SUPERFICIAL TEMPORAL ARTERY is the next considerable branch of the external carotid. It lies immediately under the skin. It passes between the jaw and the flap of the cartilage of the external ear. From it the following branches take their rise: *a branch* to the parotid gland; *a small branch* to the masseter muscle, which anastomoses with the inferior labial artery; and there is *a branch* which crosses the face in company with the duct of the parotid gland, and communicates with the facial and internal maxillary arteries: *a branch* from the superficial temporal, enters the meatus auditorius externus, and communicates with the exterior auricular.

The DEEP TEMPORAL is sent off behind the condyle of the jaw, and passes under the aponeurosis of the temporal muscle. Small *branches* of this artery, called the *anterior auricular*, are distributed upon the fore-part of the ear.

The superficial temporal, after passing across the zygoma, divides into *anterior* and *posterior branches.*

The *anterior* supplies the skin and muscles of the fore-part of the head, and anastomoses with the ocular and facial arteries.

The *posterior* branch divides into a number of branches, which supply the back-part of the head, and communicates repeatedly with the branches of the occipital artery.

That kind of aneurism, called *the aneurism by anastomoses*, is by no means unfrequent on the head and face. Such tumours are of very different sizes: I have sometimes seen them as small as a sixpence, and sometimes covering the greater part of the cheek.

These tumours consist of a congeries of small arteries and veins; and when the tumour is large, it receives blood from

different sources. When such tumours are small, they may be easily removed; but when large, it is often very difficult to take up by ligature all the vessels that supply them with blood.

In describing the arteries of the face, the anastomoses between these have been mentioned; and hence when a tumour, *formed by a plexus of vessels*, occurs upon the face, it is very difficult to take up all the vessels which lead to it, and if that be not done, the disease is not cured. I have seen the angular artery taken up near to the angle of the jaw; but the disease was not cured, for all the arteries that fed it were not taken up. Another method is to dissect out such tumours. I had occasion, with Mr A. Burns, to visit a man, on whose face a large purple-coloured tumour grew: it gradually extended upwards towards the eye. The tumour was dissected out by Mr A. Burns, and the patient obtained a complete cure.

Mr Liston has described the case of a woman, "who had a constant beating pain in the left cheek, and upper jaw, along the alveolar process, stretching to the throat, and indeed covering the whole head." The pain was without respite, and so violent that she constantly supported her head, unable to use any exertion.

"In my examination," Mr Liston says, "I put my thumb on the carotid; she immediately exclaimed she was quite relieved. I passed a small ligature under the carotid. For some time the pains were relieved, but since then, I understand, they have returned with considerable violence *."

In removing the parotid gland †, or tumours growing upon the cheek, or in the extirpation of tumours growing from the under jaw, it is prudent, on the part of the surgeon, with the view of preventing hæmorrhagy, to begin his operation by throwing a ligature upon the common carotid artery of the same side. After having secured the carotid artery, even a portion of the under jaw has been cut out.

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* Edinburgh Medical and Surgical Journal, January 1820.

† Three cases have been published by Dr Weinhold of Halle, in which this gland has been removed with success.—Vide Beclard, Archia General, January 1824.

Dr Mott of New-York, on one occasion, removed an osteo-sarcomatous tumour, which grew from the angle of the under jaw-bone, to the first bicuspid tooth; and Lallemand cut out the whole jaw.

On another occasion, Dr Mott's patient was completely well on the 37th day after the operation. The same gentleman sawed through the under jaw-bone opposite to the second bicuspid tooth of the left side, and took the bone from its socket, in order to remove a large tumour which grew from under the jaw. The patient died on the fourth day after the operation.

Upon removing the ascending branch of the under jaw, we meet with an artery passing between the external and internal pterygoid muscles: this has been called the *Internal Maxillary Artery.* It arises about the middle of the ramus of the jaw, and turns inwards in front of the external pterygoid muscle. A branch of this artery is sent to the dura mater through the foramen ovale, and another and still larger branch passes through the foramen spinale to the same membrane.

A considerable branch of this artery enters into the posterior mental hole, along with the inferior maxillary nerve: it passes in a canal through the substance of that bone, to which it gives several small branches, and also to the teeth, which enter these at the extremities of their roots: what remains of the artery comes out at the anterior mental hole, and anastomoses with the labial arteries, which are branches of the external maxillary artery. The internal maxillary also gives one or two branches to the temporal and masseter muscles, and also a branch which passes through the glenoid fissure to the tympanum of the ear.

This artery, in its progress upwards, also gives small branches to the pterygoid, buccinator and zygomatic muscles. Branches of this artery pass through the infra-orbitar canal, which gives small branches to the dura mater, lacrymal gland, and to the coats of the superior maxillary nerve; and after coming out at the foramen infra-orbitarium, it freely anastomoses with the nasal and transverse facial branches of the external maxillary artery: small branches of it then pass downwards

to supply the membrane that lines the antrum maxillare. A branch of the internal maxillary also passes through the posterior palatine hole, to supply the back part of the soft palate, and one branch of it passes to the palate, and another part through the foramen incisivum into the nose.

The last branch of the internal maxillary artery has been called the *Spheno-Palatine*: it passes through the hole of that name, and is spent upon the mucous membrane that lines the upper and back part of the nose. A few small branches pass into the posterior cells of the ethmoid bone.—It is proposed to describe the *Internal Carotid Artery*, and its branches, in a subsequent part of this book, together with the organs on which they are distributed.

Of the Arteria Innominata.

This great artery is common to the right carotid and right subclavian arteries, and is about an inch in length in most individuals. But it is not invariably of the same size or length: in general, it ascends no higher than the top of the breast-bone, and then divides into two great trunks; but Mr A. Burns shewed me instances in which this artery ascended as high as the lower part of the thyroid gland, where it might be wounded in opening the windpipe.

There is no dread of a want of supply of blood in the right arm, though a ligature be thrown around this artery, and hence of late there have been two instances published, in which a ligature has been put around this artery in a living person. The one operation was performed by Dr Graeffe * of Berlin; the other by Dr Mott, Professor of Surgery in the University of New-York.

In this last case, there was a prominent pulsating tumour below the collar bone, accompanied by cough and severe pain in the shoulder.

Dr Mott began his incision over the tumour, divided the skin, sternal portion of the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, which exposed the sheath containing

* Vide London Med. and Phys. Journal, vol. xlix. p. 475.

the carotid artery, par vagum, and internal jugular vein. He drew the artery towards the windpipe, and thus laid bare the subclavian artery for half an inch, which was found diseased: therefore, by a round-edged knife being passed a little lower behind the breast-bone, he passed a silk thread around the arteria innominata, which did not occasion any unpleasant sensation: thus the tumour was reduced one-third of its size. On the 26th day after the operation the patient died.

Of the Subclavian Arteries.

The right subclavian takes its rise in common with the right carotid, and crosses over the windpipe, and then gets to the axilla; but the left, and smaller branch, is directed somewhat downwards to the axilla.

These arteries pass under the collar bones, over the horizontal flat upper surface of the first ribs, and transversely between the anterior and middle scaleni muscles.

The left subclavian artery, in its course to the axilla, is found behind the sternal extremity of the sterno-mastoid muscle, covered by the subclavian vein, and the par vagum; and the lower cervical ganglion of the sympathetic nerve lies behind it.

The recurrent nerve passes around the right subclavian artery in its course to the larynx, and the par vagum passes on the left side, around the arch of the aorta. The right subclavian artery has thicker coats than the left, and the pulse is rather stronger in the right than in the left arm.

The right subclavian and right carotid arteries in some individuals take their origin separately from the arch of the aorta. In my Thesis, I have described an instance, in which the subclavian artery took its origin from the top of the descending aorta; and, instead of passing upwards along the front of the windpipe, passed between it and the gullet.

An aneurism of the subclavian artery may be mistaken for the same disease of the aorta.

I was consulted, along with the late Dr Wardrope and the late Mr Fyfe, by a gentleman from Glasgow, about the nature of whose case some difference of opinion at first prevailed.

After having bent the patient's head forwards, a tumour, which had a distinct pulsation, synchronous with that of the heart, was distinctly perceived, placed upon the clavicular portion of the sterno-mastoid muscle, which could be very much reduced in size by pressure; and on the pressure being removed, the tumour regained its former bulk. The pulsations of the common carotid artery on the same side, were more feeble than those of the opposite side.

We gave it as our opinion, that there was not room for any operation. He was advised to live low, to avoid violent exercise, and every cause tending to accelerate the flow of blood.

The tumour became rather larger, and created some degree of difficulty in swallowing. The patient lingered on for some time; the tumour gradually increased in size, and he died at length exhausted.

I had occasion to examine the parts after death. There was an aneurism in the arch of the aorta, including the arteria innominata. The tumour ascended above the breast-bone, and pressed the carotid artery against the spine and the origin of the subclavian artery, and displaced the windpipe.

The following arteries are derived from the subclavian:

The INTERNAL MAMMARY takes its rise from the inferior part of the trunk of the subclavian, opposite to the first rib; it passes behind the collar-bone, where it is joined to the breast-bone; it descends between the pleura and cartilages of the true rib, and between the sterno-costalis and intercostal muscles. The intercostal mammary artery gives branches to the thymus gland, a branch to the pericardium, a branch which accompanies the phrenic nerve, and is spent upon the diaphragm, and anastomoses with a small branch of the thoracic aorta, which also supplies the diaphragm.

The internal mammary artery also gives branches to the sterno-hyoid, sterno-thyroid, and intercostal muscles, and to the mediastinum anterius. This artery then emerges from the thorax under the cartilage of the seventh rib; and on the back part of the rectus muscle of the abdomen, it divides into

an external and internal branch. The former is distributed on the transverse muscles, and anastomoses with the epigastric, by two or three small branches of the intercostal and lumbar arteries.

When the main trunk of an artery is obstructed, the collateral branches, or those arteries by which the blood reaches the same place, become much enlarged; of this latter remark the internal mammary artery affords a striking instance, for, though of small size, yet it has sometimes become so large, when the aorta has been obstructed, that the greater part of the blood which passed through the aorta to the lower limbs, has been diverted from its usual route, and has passed through the internal mammary and epigastric arteries.

In a case described in DESAULT's Journal, in which the trunk of the aorta was in a great measure impervious, this artery, and also the epigastric, was very much enlarged, so that the greater part of the blood had probably been diverted from its usual channel, and had passed to the inferior extremities by the medium of the internal mammary and epigastric arteries.

The VERTEBRAL is the largest artery that is sent off from the subclavian. In its progress upwards to the passage in the transverse process of the 6th and 5th cervical vertebræ it is covered by the ganglia of the sympathetic nerve; it inclines outwards and upwards to the foramen in the transverse process of the atlas, and then is bent backwards in a fossa in the upper surface of the atlas. It then passes forwards and upwards to the foramen magnum ossis occipitis, where it joins the vertebral artery of the opposite side.

The vertebral artery sometimes takes its origin from the arch of the aorta.

Mr A. BURNS informs us, that he also had met with such a case; and, in the same subject, "on the right side, the vertebral artery originated from the subclavian, alongside of the carotid artery. It afterwards ascended along the surface of the rectus major anticus, attached to the sympathetic nerve, till it reached the third cervical vertebra. At this part of

tbe neck, just a few lines below the bifurcation of the carotid, the vertebral artery entered the vertebral canal.

" The artery lay exterior to the sheath of the cervical vessels and nerves; but in its whole course parallel to, and immediately behind, the common carotid artery. It was nearly as large as the barrel of a quill."

Mr Burns adds, " In taking up the carotid artery, it might have embarrassed him (the surgeon), for it was only separated from the carotid by a thin interposed sheath. If this vessel had become aneurismal, the *tumour produced would, in almost every point, and in every essential character, have resembled carotid aneurism.*"

When both carotid arteries of a dog were obstructed by the application of a ligature, I have observed, that the inferior and superior thyroid were much enlarged; and also the vertebral arteries.

The INFERIOR THYROID, GUTTURAL, or LARYNGEAL ARTERY, takes its rise from the fore-part of the trunk of the subclavian artery, near to the origin of the vertebral and internal mammary arteries. The origin of the artery is covered by the sternal extremity of the sterno-cleido-mastoid muscle. This artery ascends obliquely inwards about two inches, and then passes behind the carotid communis artery; it then descends, describing a tortuous course, till it reaches the thyroid gland, where it divides into a number of small branches, which pass into the substance of the thyroid gland, and anastomose with those of the superior laryngeal artery. From this artery small branches are sent to the larynx, pharynx, and œsophagus, and two or three small branches descend along the trachea, and anastomose with the bronchial artery.

I had occasion to see an instance in which the thyroid artery ascended in front of the windpipe, and therefore might have been divided in opening that tube.

The throwing a ligature around the superior thyroid artery was performed by Sir W. Blizzard, whilst I was his pupil, at the London Hospital, twenty-four years ago; but the wound degenerated into a foul ulcer, and the patient died from the loss of blood.

Within these two years the same operation has been performed with success, by Mr Coats, and is described by him in the following manner:

"I cut down on the left superior thyroideal artery, and having dissected it from its accompanying nerve, by means of a bent probe, I passed under the vessel a small round ligature, which was drawn moderately tight, and tied.

"The ligature separated on the ninth day, and the wound was completely healed on the fourteenth.

"Her breathing was much improved, and the size of the tumour reduced nearly a half *."

Great danger must attend the throwing a ligature around the subclavian artery, before it passes between the scaleni muscles, for the par vagum and phrenic nerve lie above the artery. On the left side of the body, the thoracic duct is situated in front of the artery, in its course to the subclavian vein. The phrenic nerve and par vagum pass before the artery, and the inferior cervical ganglion of the sympathetic nerve is placed behind, and, on the right side, the recurrent nerve passes round that artery.

Professor Colles of Dublin has made the subjoined very judicious observations, on taking up the subclavian artery before it has passed between the scaleni muscles.

"To lay bare the right subclavian artery before it reaches the scaleni, will not be found difficult by any surgeon possessed of a steady hand, and a competent knowledge of anatomy; but I fear that, with the utmost dexterity, much difficulty will be experienced in passing and tying the ligature around it, even in the most favourable case. This operation, difficult on the right, must be deemed *impracticable on the left subclavian artery;* for, the great depth from the surface at which this vessel is placed, the direct course which it runs in ascending to the top of the pleura, the sudden descent which it makes from this to sink under the clavicle, and the danger of including in the same ligature the eighth pair of nerves, the internal jugular vein, or the carotid artery, which all run

* Medico-Chir. Trans. of London, vol. x. p. 314.

close to, and nearly parallel with, this artery, all constitute such a combination of difficulties, as must deter the most enterprising surgeon from undertaking this operation on the left side *."

The subclavian artery, following somewhat of a transverse course, passes between the anterior and middle scalenus muscle, and is somewhat bent downwards in its progress to the first rib.

The late Mr Ramsden demonstrated the possibility of throwing a ligature around the subclavian artery after it has passed between the scaleni muscles; and Mr Liston, of this city, successfully performed this operation four years ago †. The following is his account.

" Having placed my patient in a proper light, with his head slightly raised by pillows, I commenced my operation by a division of the integuments immediately above the clavicle, in a line with it, and about two and a half inches long, and another incision on the outer side of the sterno-mastoid muscle of one inch and a half, falling perpendicularly upon the middle of the first. The two flaps were then dissected back, so as to expose the external jugular vein, which, as lying in the way, was cut across, and the lower orifice (that pointing upwards) which alone bled, secured. Though I had determined to tie every vessel of consequence as I went along, still I was unwilling to put ligatures on the veins if I could possibly avoid it. The other orifice of the jugular, as it gave no trouble, was therefore left untied. In this stage of the operation, the transversalis humeri or supra-scapular artery, was necessarily divided and tied. After dividing part of the omo-hyoideus, I then pursued my dissection to the level of the axillary plexus of nerves. Having cut carefully on their anterior surface, so as to feel pulsation distinctly, and detaching what I imagined to be the artery, I passed a ligature round it. I then carried the ends of the cord through a *serre ligature*, so as to ascertain if, by compression of this body, I could

* Vide Edin. Med. and Surg. Journal, July 1820.

† Ibid. July 1820.

stop the circulation or not. In doing this, one of the sides of the ligature was cut through in the eye of the instrument, which had not been properly rounded off, but at a considerable distance from the bottom of the wound. Having laid hold of the end again, and ascertained that one of the nerves, to which the pulsation had been communicated, was surrounded instead of the vessel, I retained the ligature, for the purpose of holding the parts out of the way, till, by a little cautious dissection, I exposed the artery as it passes through the scaleni. Here, however, I had reason to believe the vessel unsound, partaking so far of the aneurismal dilatation, and determined on securing it nearer the heart. In this part of the operation, I received the greatest assistance from the spatulas recommended by Dr Colles of Dublin. I was indebted to an old pupil of his for a set of them, which he brought me before the operation. Those I used were made of sheet copper; they are so soft as to be bent easily to any shape, which they retain. With them my assistants, whilst their hands were out of the way, were enabled to hold aside the surrounding soft parts on all sides, so as to protect them from the knife; to prevent oozing from the small vessels; and, at the same time, give me a complete view of the bottom of the wound. These spatulas are of the greatest use in the ligature of all deep-seated vessels, the iliacs, &c. or in any deep dissection whatever. In fact, I consider them as the greatest addition made to our surgical instruments for many years. Having thus, then, gained a view of the vessel, and ascertained its condition, I proceeded cautiously to divide the scalenus anticus. Having cut through its whole thickness, to about its middle, in order to avoid the phrenic nerve, I contented myself with denuding the artery, by separating those fibres next it, leaving the more superficial ones entire. In this way, as if by burrowing under the muscle, the artery was fully exposed for the passage of the ligature. This part of the operation, which, by all who have attempted it, is considered the most difficult, and for which so many proposals have been made, and instruments invented, was at once accomplished with the simple needle, which I had employed in many cases

of aneurism, in different situations, previously. For a number of years I had practised this operation, as well as others, on the dead subject; and, from the repeated trials I had made, was satisfied, that, even in great deepening of the wound from elevation of the clavicle, I should be enabled more readily to achieve my purpose with this instrument than with any other, of whatever fashion. The difficulty appeared to be, not in bringing up the point of the needle, so as to catch the loop of the ligature, but in getting it beyond the vessel. This is readily accomplished with the instrument I used, (which is delineated in a plate in the Journal). From its construction at the point, as soon as this can be seen or felt, the ligature is immediately laid hold of by the hook or forceps. Having passed the needle, armed with a strong round silk ligature, under the vessel with but little difficulty, I soon exposed the point, by rubbing the cellular substance betwixt it and my finger, and, with a small hook, laying hold of the loop, withdrew the instrument. I then, by tightening the two ends of the cord, and pressing with my finger betwixt them, so as to command the pulsation, assured myself, that the ligature was properly placed."

The subclavian artery then sends off the POSTERIOR CERVICAL, which sometimes takes its rise in common with the anterior cervical and inferior thyroid arteries.

This artery rises up in the back-part of the neck, giving branches to the scaleni and trapezius muscles, splenius and trachelo-mastoideus muscles, and it anastomoses with the occipital artery.

The *anterior cervical* is also sent off from the subclavian artery; it is covered by the sterno-mastoid muscle; it ascends along the anterior scalenus muscle, passes under the omo-hyoid muscle, and suddenly divides into branches, which are distributed upon the middle scalenus muscle; and it communicates with the vertebral and occipital arteries.

The origin of this artery is by no means uniform.

The large artery called ARTERIA DORSALIS SCAPULÆ SUPERIOR, is next sent off; it passes behind the origins of the sterno-mastoid muscle, from the collar-bone; follows the course of

that bone, by which it is well protected from external injury, and in its course gives small branches to the sterno-mastoid, sterno-hyoid, and subclavian muscles.

Near to the humeral end of the collar-bone, this artery divides into branches, the largest of which lies under the trapezius muscle; and, after passing through the notch in the superior costa of the scapula, divides into many branches, which are spent upon the muscles placed on the back part of the scapula, and anastomoses with the arteria dorsalis scapulæ inferior.

The origin of this artery is very different in different individuals: sometimes it arises from the thyroid artery, and being occasionally of considerable size, may, in its progress along the back part of the collar-bone, be mistaken for the subclavian artery.

The arteries called SUPERIOR-INTERCOSTAL, are also branches of the subclavian; they are placed over the head of the first and second ribs, and at length reach the intercostal spaces.

These arteries send branches to the gullet and spinal cord, and they anastomose with the inferior intercostal arteries.

The trunk of the subclavian then passes over the flat surface of the first rib into the axilla, where it is covered by the corresponding vein, and is surrounded by the axillary plexus of nerves, lymphatic glands, and fat; and in that situation, the artery is called AXILLARY. It is protected by the great pectoral muscle, and also by the tendinous portion of the lesser pectoral muscle.

I received lately from Mr HUNTER, one of the surgeons to the Hospital of this city, a portion of the axillary artery which had been lacerated during life, in consequence of the person having fallen from a considerable height. Owing to the effusion and coagulation of blood in the axilla, there was no pulsation whatever to be felt in the radial artery of the same side, before the patient's death. It is remarkable, that the axillary artery, where the arm has been torn off, discharges but a small quantity of blood, owing probably to the contortion of the arm.

Branches of the axillary artery are distributed upon the external parts of the thorax, and hence have been called THORACIC.

There is considerable variety as to the size, number, and mode of distribution of the thoracic arteries: sometimes there are only two or three trunks; but, on other occasions, five or six; and sometimes all arise by a common trunk.

By Thoracic arteries, authors understand all those branches which arise from the axillary artery, excepting the scapulary and the two circumflex arteries.

The thoracic may be divided into two classes. The superior are spent upon the serratus, intercostal, pectoral muscles, and mammæ, and anastomose with the branches of the internal mammary and superior, or longest intercostal arteries.

The *inferior thoracic arteries* supply the mammæ, axillary glands, and lesser pectoral, and serratus anticus muscles. A branch of this artery passes along the collar-bone, and dips into the substance of the subclavian muscle.

A *branch* is reflected backwards under the deltoid muscle, and anastomoses with the superior scapulary artery.

A few of the smaller branches of this artery supply the teres major, latissimus dorsi, longest head of the triceps muscle, and subscapulary muscles.

The axillary artery descends along the origin of the subscapulary muscle, to which it gives branches, and sends off the artery called INFRA SCAPULARIS, which is immediately subdivided into two branches, the SCAPULARIS INTERNA, and ARTERIA DORSALIS SCAPULÆ INFERIOR.

The SCAPULARIS INTERNA gives branches to the under part of the scapula, and to the teres major, subscapularis and latissimus dorsi muscles, and anastomoses freely with the arteria dorsalis scapulæ superior, as has been represented by HALLER.

The ARTERIA DORSALIS SCAPULÆ INFERIOR, gives several small branches to the subscapulary muscle, and to the teres major, the latissimus dorsi muscles, and to the axillary glands.

The next branch, called CIRCUMFLEXA POSTERIOR, arises

between the subscapulary and teres major muscles. It passes around the posterior part of the neck of the os humeri, and transversely under the deltoid muscle, from the inner side of the arm outwards and backwards: it then sends several small branches to the capsular ligament of the shoulder-joint, to the biceps coraco-brachialis, subscapulary, and deltoid muscles.

The next branch has been called CIRCUMFLEXA ANTERIOR. It is smaller than the former, and often arises in common with it. It is sent off between the subscapulary and teres major muscles.

It passes transversely to the outer side of the arm, between the coraco-brachialis, and shorter head of the biceps muscle, to which it gives branches, and around the fore-part of the neck of the os humeri, giving branches to the deltoid and coraco-brachialis muscles. A branch of this artery is reflected upwards, and divides into several branches, which are spent upon the capsular ligament of the shoulder-joint and periosteum of the bone.

It merits attention, that the axillary artery is covered by its corresponding vein, to the coats of which the diseased axillary glands frequently adhere very intimately, and are separated with great difficulty. The vein has sometimes been opened in the act of separating the glands from this great vein, which occasionally has proved fatal.

The fore-arm receives a sufficient supply of blood, though the subclavian and axillary arteries have been obstructed.

My Father had a considerable share in introducing the improved method of treating aneurisms. He was led to suggest the propriety of throwing a ligature around the axillary artery, not only in consequence of having frequently taken up that artery in the inferior animals, but also from a case which was communicated to him by his brother, Dr D. MONRO, who, in an axillary aneurism, which had occurred to him in the 1759, found a hole in the axillary artery, leading into the aneurismal sac; and below this place, the sides of the bottom of the axillary artery, or top of the humeral artery, had coalesced.

The above case led my father to observe, "that, in the 1*st* place, The arm, as well as the life of this person, might have

been saved by a ligature of the subclavian or axillary artery; and, in the next place, That such an operation might be practised in the case of an aneurism or wound of any artery of the superior extremities.

"After this, (he continues), in the year 1787, I sent to our Infirmary a boy of twelve years age, who had been wounded in the middle of his anterior femoral artery, with a pen-knife, and who was recommended to my care by Mr WETHERSTOUN, surgeon in Lauder. He was cured by tying up the trunk of that artery: and, very lately, I had the satisfaction of seeing him in my house, stout in his limbs, and without a halt, or other sign of lameness."

The axillary artery then quits the axilla; and at the inner and inferior part of the ball of the os humeri, it lies along the inner-edge of the coraco-brachialis muscle; hence, when the head of the os humeri has been dislocated, the artery is so much elongated and compressed by the displaced bone, that the pulse at the wrist of the same side is often much weaker than that of the sound one.

The artery then advances towards the front of the axilla, and pursues its course, together with its corresponding vein, along the os humeri, covered by the tendinous aponeurosis of the arm, and radial nerve, along the inner side of the biceps flexor cubiti; and it is here called *Humeral artery*.

As the humeral artery and radial nerve adhere closely to each other, the nerve may, by an inattentive surgeon, be included in a ligature, which renders the ligature insecure, and is often followed by bad consequences, on account of the injury done to the nerve.

The SPIRALIS HUMERI, is the next considerable artery which is sent off from the humeral artery. It takes its rise near to the insertion of the teres muscle into the humerus; it follows a spiral course downwards and outwards around the os humeri, between the long and short heads of the triceps muscle, and comes out on the outer side of the arm, between the brachialis internus, and supinator radii longus muscles.

This artery is, in some instances, as large as the radial artery.

The smaller branches of this artery pass upwards, and anastomose with the branches of the humeral and scapulary arteries; and one of these passes into the substance of the os humeri, near to the middle of that bone; and hence has been called the *Nutrient* artery of the bone.

The several smaller branches of the humeral artery, which are not constant as to the place of their organ, size, or course, are distributed upon the biceps brachialis internus, and teres major muscles; and a branch generally communicates with a reflected branch of the radial artery.

The next considerable branch has been called the PROFUNDA MINOR: it is spent chiefly on that part of the triceps muscle which is in the vicinity of the elbow-joint. Near to the elbow-joint, an *anastomosing branch* is given off, which divides into small arteries, which are spent upon the parts that cover the internal condyle of the humerus, and the olecranon ulnæ.

The humeral artery passes for some way along the ulnar side of the biceps flexor cubiti; and at or very near to the elbow-joint, it lies on the brachæus internus muscle, and follows the course of the tendon of the biceps; which being much narrower than the belly of that muscle, it of course gets near to the middle of the joint: it then passes beneath the tendinous aponeurosis of the biceps flexor cubiti.

The humeral artery may be readily compressed against the os humeri in the above course; and, in cases of aneurism, compression has been employed by some surgeons, in preference to the ligature; but the pain arising from long-continued pressure, has been found to be intolerable to the patient. If pressure be employed, it ought to be limited to the artery, by the apparatus adapted for that purpose.

The humeral artery then passes towards the middle of the elbow-joint, and is seated deeper, in a space which is externally bounded by the supinator radii longus muscle, and internally by the pronator teres, and is placed behind the brachialis internus muscle; having in front the tendinous fascia of the biceps. About an inch below the joint, the artery is subdivided into two large arteries called the *Radial* and *Ulnar*. But, in many instances, the humeral artery opposite to the ball

of the os humeri, or lower down in the arm, divides into the ulnar and radial arteries, and sometimes in both arms of the same person.

It generally happens that, when the radial and ulnar arteries are sent off at the humerus, that the two branches lie in immediate contact with each other, as far as the elbow-joint; but, in a few instances, one of these runs immediately under the skin and above the tendinous aponeurosis of the arm. This branch may inadvertently be opened during venesection. In some instances, the humeral artery divides into two branches, and these are again united into one trunk. I have two specimens, in which there is an additional artery, which follows the same course as the humeral artery, and which is united with the radial branch of that artery, near to the elbow-joint.

I have also specimens in which the interosseous artery takes its rise from the humeral. It is necessary to be aware of these varieties as to the distribution of the arteries of the arm, in performing the operation for the cure of aneurism of the humeral, radial, or ulnar aneurisms.

The incision should be made in a direction parallel to the biceps flexor cubiti, taking care to avoid the internal cutaneous nerves, through the skin and tendinous aponeurosis of the arm. The surgeon ought also to bear in mind, that the artery, when laid bare, does not invariably pulsate; and hence the difficulty of distinguishing it from the accompanying vein or radial nerve.

The two great branches of the humeral artery, the radial and ulnar, are not of equal size. The latter is the larger.

The ULNAR ARTERY passes behind the pronator teres, the flexor muscles of the hand, and then between the flexor sublimis and profundus digitorum. It sends upwards a considerable branch, called RECURRENS ULNARIS, which is placed under the flexor muscles, and the anterior and inner side of the elbow-joint, and anastomoses above the internal condyle with the smaller branches of the arteria profunda humeri.

The artery then passes along the ulna, giving off several, small branches to the fore-arm.

The next branch of the ulnar artery has been called the IN-

TEROSSEA POSTERIOR, as it perforates the upper part of the interosseous ligament. From this artery, there is also a recurrent branch, which is reflected along the supinator radii brevis and anconeus muscles, and anastomoses with several small branches of the humeral artery, on the back part of the elbow-joint.

The posterior interosseous artery is continued downwards to the back part of the fore-arm, and its smaller branches supply the extensor muscles of the fingers, and the posterior part of the ligament at the wrist.

The INTEROSSEA ANTERIOR is sent off below the posterior, under the long flexor of the thumb, and is considerably larger than it. From this artery there are small branches sent to the pronator teres and supinator radii brevis.

This artery passes downwards along the fore-part of the interosseous ligament, and supplies the flexor digitorum profundus with blood.

A little above the wrist, this artery perforates the interosseous ligament, below the pronator radii quadratus, to which it gives small branches, and also branches to the ligaments and tendons of the posterior part of the wrist, and anastomoses with the smaller branches of the posterior interosseous artery and of the radial artery.

At the carpal extremity of the ulna, a small branch is sent off from the ulnar artery, which passes behind the tendon of the flexor carpi ulnaris to the back of the hand, and, uniting with the smaller branches of the radial artery, forms a plexus of vessels on the back part of the wrist, hand, and fingers.

The ulnar artery then sends off many small branches, which supply the fore-part of the wrist; and, passing over the annular ligament, form the superficial palmar arch, which extends between the root of the metacarpal bone of the little finger, near to the first bone of the thumb.

The following branches are sent off from the palmar arch: *three digital branches* which run in the interstices of the metacarpal bones to the roots of the fingers; each is subdivided into two branches; one of these runs along the radial margin, and the other along the ulnar margin of the finger: all the

fingers are therefore supplied from this source, excepting the outer margin of the little finger, and the outer margin of the fore-finger.

Towards the points of the fingers, the arteries of opposite sides freely communicate with each other, and form an intricate plexus of vessels. At the roots of the fingers, each of the digital arteries receives a small branch from the deep seated arch, and an artery from the superficial arch supplies the thumb.

The ulnar artery also sends a branch, named *ulnaris profunda*, near to the root of the metacarpal bone of the little finger, which anastomoses with the deeper-seated arterial arch, formed by the radial artery, and assists in forming the deep palmar arch.

From the superficial arch, an artery is also sent to the thumb.

At the roots of the fingers, there is generally a communication between the superficial and deep-seated arterial arches.

The RADIAL ARTERY, the smaller branch of the humeral, passes over the pronator teres, and then along the fore-part of the radius between the supinator radii longus, and flexor carpi radialis. This artery, in its course downwards, becomes more superficial, and at the wrist lies close on the radius. It sends off a *recurrent branch*, which passes between the tendon of the biceps, and supinator radii longus, and anastomoses at the outer part of the elbow-joint with the profunda humeri.

There are many *small branches* sent from this artery in its course downwards along the radius, to supply the neighbouring muscles.

A branch of the radial, called SUPERFICIALIS VOLÆ is sent off at the wrist. It passes through the abductor pollicis to the palm of the hand. This artery sometimes anastomoses with the ulnar arch. The size of this branch is various in different individuals.

There are also *small branches* of the radial artery distributed upon the ligaments and bones of the wrist, and to the back-part of the metacarpus and fingers.

At the carpal end of the radius, the radial artery turns back on the fore-part of the tendons of the extensor muscles

of the thumb, and afterwards passes through the abductor indicis; after which, it divides into the following branches: the ARTERIA MAGNA POLLICIS, which takes its rise nearly opposite to the root of the metacarpal bone of the thumb, passes along the side of the thumb next the fingers; the RADIALIS INDICIS, which passes along the side of the fore-finger next the thumb; the PALMARIS PROFUNDA, which, passing across the hand between the roots of the metacarpal bones and flexors of the fingers, assists in forming the *deep-seated arterial arch of the palm of the hand*, from which a number of small arteries are derived which supply the interossei muscles.

The knowledge of these variations in the distribution of the bloodvessels of the arm is of the utmost importance to the surgeon in various operations.

There is considerable variety as to the distribution of arteries in the palm of the hand: the radial artery sometimes forms the superficial arch, sometimes the superficial arch is formed by the radial, ulnar, and interossei, arteries.

If an artery be punctured, the bleeding is stopped by the injection of blood between the artery and its sheath; thus a coagulum is formed, which compresses the orifice of the artery; after which, the edges of the wounded artery inflame, coagulable lymph is effused, and the wound is healed by adhesive inflammation. But if the wound be extensive, according to Dr JONES *, the canal of the vessel is more or less obstructed by the lymph. But if an artery be divided, the artery retracts, and the bleeding is stopped by the obliteration of the canal of the artery: the blood then flows by the lateral anastomosing vessels, and thus the life of the part is preserved.

Bleeding is most successfully checked by the compress or ligature. A compress is applied so as to bring into contact the lips of the wound, and to compress the artery above the

* On Hæmorrhage. A bleeding is stopped, according to Dr JONES, by the formation of a plug at the mouth of the artery,—the inflammation and consolidation of its extremity by an effusion of lymph within its canal, and between its coats, and in the cellular sheath around it,—and also by the retraction and constriction of the artery.

wound; or a compress of lint or sponge is put into the bottom of the wound, which presses directly upon the orifice of the artery. By the use of the compress, the outward wound sometimes heals, but not that in the artery, and hence the blood escapes into the surrounding parts; or the piece of sponge applied to the orifice of the artery may slip off. Besides, the application of a compress impedes the collateral circulation, and proves a cause of swelling of the arm.

When a considerable artery has been wounded, the ligature is more to be depended upon, and it should be applied as near as is possible to the orifice. Both ends of the wounded artery should be secured, as, on account of the free anastomoses, it may pass through the lower part of the wounded artery, by which a great deal of blood may be lost.

If the ligature be applied at some distance from the wound in the artery, or to the trunk, where a branch has been opened, bleeding may follow, as the blood may flow from the lower end of the artery, or from the upper, through the medium of the branches connected with the trunk between the ligature and the wound.

It may happen, that there may be no loss of blood, though a ligature has been applied only above the wound of the artery, as the lower part of the wound may be closed by a coagulum of lymph.

In short, a ligature should be applied to both extremities of a large artery that has been wounded; for there is great difficulty in keeping the edges of a punctured artery in contact by the compress.

Of the Veins of the Superior Extremities.

There are two sets of veins proper to the superior extremities, a superficial and deeper-seated set. The superficial veins are placed under the skin, and between it and the tendinous aponeurosis; whereas the deeper seated veins accompany the arteries. Both sets of veins communicate frequently with each other, and both are provided with valves.

There is great variety as to the distribution of the veins in different individuals.

The *superficial veins of the back of the hand* go chiefly to the veins of the fore-arm, and to the radial and ulnar veins.

The continuation of the ulnar veins forms what has been called the *Basilic Vein*, which is placed on the inner edge of the biceps muscle, and immediately over the humeral artery, the pulsations of which may be felt through the coats of the vein.

The ulnar artery in some instances perforates the tendinous fascia of the fore-arm, and follows the same course as the basilic vein, to which it is fixed by short cellular substance: and hence this large artery might be wounded by an inattentive surgeon in opening the basilic vein.

The *superficial radial veins* on the anterior part of the fore-arm communicate with the radial and ulnar veins, and with a trunk, called the *mediana longa.*

The *mediana longa* crosses over the radius, and divides, generally, below the elbow, (I have seen this division take place three inches above the elbow-joint), into the *mediana cephalica* and *basilica.* The former terminates in the cephalic above the elbow, and the latter crosses over the humeral artery, and ends in the basilic vein, which joins with the humeral vein.

The *cephalic vein* runs up the arm on the outer or radial side of the biceps muscle, between that muscle and the triceps; and, passing between the pectoralis major and deltoid muscles, dips down, and terminates in the axillary vein.

The scapular and thoracic vein unite with the axillary vein.

The deeper-seated veins, named *Venæ Comites Satellites,* follow the same course as the arteries; they join the more superficial, and form the Axillary Vein, which, being joined by the circumflex and thoracic veins, forms the *Subclavian Vein:* this passes between the clavicle and first rib; receives the cervical veins, and those corresponding with the superior dorsal scapulary artery; and then passes on the fore part of the anterior scalenus muscle.

The subclavian vein then joins with the vertebral, internal jugular, and external jugular veins, internal mammary veins, and left superior intercostal veins.

The subclavian vein of the left side then crosses the three great arteries which arise from the arch of the aorta; and, opposite to the cartilages of the first ribs, uniting with the corresponding subclavian vein, forms the *Vena Cava Superior.*

A communication is sometimes established between the basilic vein and the subjacent artery, in consequence of the artery having been wounded during the operation of venesection. This has been called the *aneurismal varix.* The blood in this disorder is not effused into the neighbouring cellular substance, but passes directly into the superincumbent vein; for there is a sort of canal formed between the fore-part of the artery and the back-part of the vein.

The tumour in this aneurism attains but a small size; has an oblong form, and its longer diameter in the direction of the arm, being formed by the expansion of the coats of the vein; and in the centre of it, the place where the vein had been opened is visible. The tumour, which is colourless, the skin not being inflamed, pulsates, or rather communicates a tremulous or thrilling sensation to the finger, for the vein receives the blood at intervals from the subjacent artery.

As the aperture in the artery made by the lancet is small, on applying the ear, a hissing noise may be heard, as if (to make use of Dr W. Hunter's phrase, to whom is due the merit of having first detected the nature of this disorder,) "*there was a blast of air through a small hole.*"

As at the bend of the arm, a good deal of blood is diverted from the artery, and flows into the vein that lies over it, the pulse at the wrist of the affected arm is not so strong as that in the other.

There is little or no pain in the tumour, no inflammation of the skin over it; and when it is compressed, the blood may be squeezed out, but, on the pressure being removed, the tumour swells out again. If the arm be raised above the head, the tumour becomes flaccid, but it is tense when the arm hangs by the side, and when the return of the venous blood to the heart is prevented by the tournequet.

Mr Park has described a modification of this kind of aneurism, which may be called the *Varicose*; in which there

is a sac between the vein that had been opened and the subjacent artery, which communicates with both.

It is seldom required to perform any operation for the cure of aneurismal varix, or varicose aneurism, as these diseases often remain stationary for a number of years.

In consequence of wounds, communications have been formed between neighbouring arteries and veins, as between the subclavian artery and its corresponding vein, according to LARREY; and between the popliteal artery and its corresponding vein, according to BOYER and LASSUS.

But it more frequently happens, when the humeral artery has been wounded during venesection, that the blood does not find its way into the superincumbent vein. It escapes into the cellular substance behind the vein, and between the muscles.

The flow of blood is stopped by the formation of a clot over the orifice of the wound in the artery, in consequence probably of the pressure that has been applied. The lips of the wounded artery are united by the effusion of lymph, and the wound of the skin over the artery also heals: thus the blood is prevented from diffusing itself through the adjacent cellular substance, and the tumour attains but a small size, and is circumscribed.

But owing to the obliquity of the wound of the humeral artery, the blood sometimes insinuates itself into the cellular substance for some distance from the orifice of the humeral artery: the whole arm assumes a purple colour, and mortification follows.

The former has been called the *circumscribed*, the latter, *the diffused false aneurism*.

The false aneurism occasioned by a wound of the humeral, may readily be distinguished from the more rare form of the disease called true, (as it does not originate from an injury), by the following symptoms:

In the former, the tumour makes its appearance immediately after the vein has been opened; and as the aperture in the wounded artery is very small, the blood cannot be forced back into it; and therefore the bulk of the tumour is not di-

minished by pressure, which happens to a certain degree in the true aneurism.

The back part of the humeral artery has been sometimes wounded during venesection, and the blood has insinuated itself behind the humeral artery: in that rare case, (which fell under the notice of my Father), the artery was stretched across the front of the tumour.

Many persons have lost their lives from venesection, or from having met with a slight wound from the point of a pin, needle, or small piece of glass; or from puncturing their fingers during dissection. I have seen many such instances, and have endeavoured by dissection to discover the cause of death.

The appearances are not uniform.

In some, there were evident traces during life, and after death, of an inflammation of the vein that had been opened. The lips of the wound of the vein had not united; they were swollen and everted, or slightly joined by a thin film of cuticle, which burst, and after which a thin watery fluid was discharged. After death the coats of the vein were evidently thickened: it was lined by a thin coating of coagulable lymph, and contained pus. In other instances the vein had a fibrous appearance like a nerve, and when pressed was evidently a solid chord; and what is remarkable, the inflammation had proceeded only as far as the axillary vein, where it suddenly stopped.

In some instances, the subcutaneous nerve in the vicinity of the vein that had been opened, was swelled and evidently inflamed.

I have never been able to satisfy myself by dissection as to the enlargement and induration of the superficial lymphatic vessels of the arm, though I have frequently observed a manifest enlargement of the lymphatic glands of the axilla.

In the greater number of instances, there was a watery fluid in the cellular membrane of the arm, shoulder, and upper part of the breast, and in some, purulent matter; and within these few years, I have seen several instances of complete disorganization in the parts of the arm.

Different opinions have been entertained as to the cause of

the symptoms. They have been supposed to be owing to an inflammation of the vein, to the injury done to the subcutaneous nerve, to the prick in the tendon or tendinous fascia, to the inflammation of the lymphatic vessels, or to that of the subcutaneous cellular substance.

That the symptoms may be in many instances imputed to an inflammation of the vein that has been opened, seems obvious, from the symptoms which preceded death, and from the appearances upon dissection.

The inflammation of the vein varies in degree, and is more or less rapid. Inflammation generally travels with a quick pace along serous membranes, and along the internal coat of a vein; but in some cases, it is slow in its progress. Dr Home told me, he had a patient, in whom the inflammation ascended and descended from the part of the vein that had been opened, at the rate of about an inch every day.

It is well known, that the jugular vein of the horse is often inflamed after it has been opened, but the animal seldom dies, even though there be at the same time a great deal of matter formed in the neck: the vein becomes closed by coagulable lymph.

Many men, however, have died after bleeding, though the vein be obstructed, a circumstance not easily to be explained: the obstruction seems to arrest the progress of the inflammation in the horse.

The similarity of the symptoms preceding the death of some individuals who have died after a vein has been opened, to those which accompany tic douloureux, and other disorders commonly supposed to originate from nervous irritation, seem to point to the nerves as the source of all the mischief. The patient tells his surgeon he has used a rusty lancet; he feels very acute burning pain following the track of the nerve; this is at one time much more acute than at another; the breathing is much affected, the heart palpitates; convulsions and death follow. All this presumptive is converted into positive evidence, by making a transverse incision into the course of the nerve, which often gives instant and perfect relief; or, in cases of puncture, by amputating the finger; and if one or

other of these remedies be not employed, the subcutaneous nerve in the vicinity of the vein that had been opened, is found much swollen, and of a purplish colour.

The red lines in the skin over the course of the lymphatic vessels of the arm, and the hard cords in that situation, as well as a swelling at the elbow and in the arm-pit, prove, that the lymphatic system has been contaminated; but with me it is still matter of doubt, whether this be the primary seat of the evil. The irritability of the lymphatic vessels, and their disposition to inflame, by the application of a stimulus, applied to any part of the arm, is admitted. When the absorbent vessels are affected, after the inoculation of small-pox, or when there is a venereal or cancerous ulcer in the arm, they are said to be affected in a secondary manner.

The thickening of the lymphatic vessels after bleeding, therefore, seems, not to be the primary affection; for it takes place when a patient has used his arm too soon and too freely after the vein has been opened, when it has been irritated by rubbing on the clothes, when the orifice of the wounded vein has festered, and when the parts around had been inflamed and hardened.

If the absorbent system be the part primarily affected, the axillary glands will, in the first place, be swollen; whereas those lymphatic vessels in the immediate seat of the puncture or part of the vein that has been opened, are, in the first place, inflamed and indurated; and that inflammation is propagated to the axillary lymphatic glands.

Collections of matter in different parts of the arm, are the frequent consequence of an injury, or of opening a vein; hence, as inflammation of the cellular membrane often ends in that manner, it has been inferred, that an inflammation of the cellular membrane is the origin of the mischief.

To me it seems probable, that an inflammation may be communicated to the cellular substance from the neighbouring parts. The dissections of that distinguished anatomist, the late Mr Wilson, and also those of Dr Clarke, prove, that inflammation is sometimes communicated to the veins in the vicinity of the womb after labour, and after the

puerperal fever; and if so, why may inflammation not be communicated from a vein in a high state of inflammation, to the neighbouring cellular substance?

In the case of the venereal bubo, there is distinct evidence of the propagation of the inflammation from the lymphatic vessels to the surrounding cellular substance. Some time after the receipt of the poison, the lymphatic vessels leading to the inguinal glands, may be felt like cords under the skin; this is succeeded by an irregular-shaped tumour, called a *Bubo;* but that tumour soon assumes an uniform oval or rounded form; the glands, which were primarily swollen, are no longer perceptible; the inflammation having been propagated to the cellular substance between them, by which the intervening spaces are filled up.

Lastly, the inflammation of the tendons, or tendinous aponeurosis, does not afford satisfactory explanation of the peculiar symptoms that sometimes follow bleeding.

If this were the source of the evil, the same symptoms would be very frequent after surgical operations, in the majority of which, some tendon, or tendinous aponeurosis, is wounded.

With respect to the cause of all the mischief which is sometimes incurred by the dissection of morbid bodies, we are still much in the dark. It has been supposed to be connected with the disease which had proved fatal to the deceased; and in proof of that opinion, instances have been quoted, of persons having suffered most severely, or of having died, from having examined the bodies of the rheumatic, the dropsical, and those cut off by inflammation of the bowels of the abdomen or pelvis. But the above does not correspond with my observation; and I could cite several instances, where there was not the slightest reason to suppose a puncture, even of the most minute description, had been received, in which the most distressing symptoms followed the examination of the healthy bodies of executed criminals; and also many instances, in which several gentlemen had been engaged in the examination of the same body, and where only *one suffered.* This leads me to impute the greater disposition of one person than of another to suffer,

a certain peculiarity of constitution. I am fully persuaded, that there is greater risk in examining a body a day or two after death, than after a week or two; and also, that much may be done to avert those consequences sometimes resulting from a puncture, by immediately washing the part with soap and water, and by the application of the nitrate of silver, or of a drop or two of nitric acid.

SECTION III.

OF THE THORACIC AORTA.

The thoracic aorta descends on the left side of the vertebræ of the back, behind the lungs, and within the mediastinum posterius; it follows nearly a straight course; and when it approaches the diaphragm, it lies more in front of the vertebræ. From the thoracic aorta, several branches are derived, before it reaches the abdomen, besides those which have been already described.

Murray has made mention of a small branch which takes its rise from the concave part of the arch of the aorta, which he calls the Superior and Posterior Pericardiac Artery; this small artery frequently takes its origin from the subclavian or internal mammary artery.

The arteries called *Bronchial*, as they are distributed upon the bronchi or lungs, take their rise from the upper part of the descending aorta.

The number and size of the bronchial arteries, are various in different subjects.

These bronchial arteries have been divided into two classes, the Right and Left.

The *right bronchial arteries* are distributed upon the right lungs, the bronchial lymphatic glands, and the inner membranes of the larger branches of the windpipe and pleura. The right bronchial arteries are sometimes derived from the superior intercostal artery.

The *left bronchial arteries*, which are unequal in size, take their rise from the fore-part of the aorta; they are subdivided into many small branches, which are distributed through the the substance of the lungs, along the coats of the pulmonary

arteries and veins, and anastomose with the smaller ramifications of the pulmonary artery.

There are scarcely two instances, in which the bronchial arteries take their rise from the same part of the descending aorta.

The ARTERIÆ ŒSOPHAGEÆ, are five or six in number. They take their rise from the aorta separately, or from the bronchial arteries; they are subdivided into very minute branches, which are spent upon the coats of the gullet, and form an intricate plexus upon the innermost coat of that organ.

There are also branches of these arteries distributed upon the posterior mediastinum and pericardium.

The SUPERIOR INTERCOSTAL ARTERY is also a branch of the thoracic aorta. There are three large branches of this artery, which are lodged within the grooves of the ribs; and the smaller branches of these arteries pass backwards to the spine, spinal marrow, and muscles of the back.

The INFERIOR OR AORTIC INTERCOSTAL ARTERIES, which are eight or ten pairs, take their rise from the back and lateral parts of the aorta, and are situated in the grooves in the under edges of the ribs, between the intercostal muscles.

The intercostal arteries differ as to size. The four uppermost are the smallest, and ascend. The intercostal arteries send small branches to the spine and spinal marrow, and intercostal muscles; and many branches pass between the ribs, and, after supplying the muscles on the fore-part of the chest, anastomose with the external mammary arteries, and also with the epigastric and lumbar arteries. Some of the small branches of the intercostal arteries are distributed on the muscles of the back.

The SUPERIOR and POSTERIOR PERICARDIAC ARTERIES, are also derived from the descending aorta, but sometimes from the subclavian and internal mammary. These arteries are distributed upon the pericardium, lungs, and gullet.

The superior branches of the inferior intercostals anastomose with the superior intercostal arteries; while the inferior branches of the inferior intercostal arteries anastomose with the epigastric and lumbar arteries.

Of the Veins which correspond with the Branches of the Aorta, and Subclavian Arteries which are proper to the Thorax.

The intercostal veins correspond in size and situation with the intercostal arteries.

The lower aortic left intercostal veins unite, and form the beginning of the *Vena Azygos*, which crosses the aorta, runs upwards along the spine, and receives, during its ascent, the intercostal veins of the right side of the chest, as also the bronchial veins, and then joins the *Vena Cava Superior*.

There is also a small venous trunk on the left side of the body, called *Left Vena Azygos*, which is formed by the superior intercostal veins, bronchial veins of the left side, and veins of the gullet.

The left, or smaller vena azygos, terminates in the subclavian vein of the left side.

I have sometimes seen this vein wanting; and, in that case, the right vena azygos is larger than usual.

The subclavian vein lies before the corresponding artery. It passes under the subclavian muscle, and over the anterior scalenus muscle and first rib.

Of the Branches of the Aorta sent off within the Abdomen, or of the Abdominal Aorta.

By *Abdominal Aorta*, is understood, that portion of the aorta which intervenes between the diaphragm and the division of the aorta into its two great branches, called the *iliacæ communes*.

The aorta passes between the tendinous columns of the smaller muscle of the diaphragm. The aperture between these columns is much larger than the aorta. It is filled by cellular substance, which unites the pleura and peritonæum; and hence the flow of blood through it cannot be affected by the contraction of the diaphragm.

The *Abdominal Aorta* is situated on the left side of the bodies of the vertebræ; and approaches gradually to the middle of the vertebræ.

The *First Branches of the Abdominal Aorta*, called PHRENIC, are distributed upon the diaphragm. These are two in number. They cross over the crura of the larger muscle of the diaphragm, and are distributed on every part of this muscle. There is much variety, in different instances, as to the distribution of the branches of this artery on the diaphragm. In a few cases, the phrenic arteries are derived from the cœliac; and, in some examples, there are three or four phrenic arteries. Some of the smaller branches of the phrenic artery are distributed upon the renal capsules, on the right side of the pancreas, liver, and ligaments of the spleen.

The next branch, called CŒLIAC, is large and short, and arises from the fore-part of the aorta, where it is placed between the crura of the diaphragm, nearly opposite to the eleventh vertebra of the back, and it lies between the lobule of SPIGELIUS and left part of the lesser curvature of the stomach. This artery subdivides immediately into three branches; the *Superior Gastric*, *Hepatic*, and *Splenic* arteries.

The SUPERIOR GASTRIC, or SUPERIOR CORONARY artery, is the smallest of the branches. It ascends, passes to the left side, and forwards; is distributed chiefly on the smaller arch of the stomach, and right side of the cardia: it then descends towards the right, along the smaller curvature of the stomach, and gives branches, which anastomose with the arteries of the gullet. The branches of this artery are distributed to the diaphragm and omentum minus; and others anastomose freely with the ramifications of the hepatic and splenic arteries.

The SPLENIC is the largest branch of the cœliac. This artery runs, in a tortuous manner, transversely along the posterior part of the body, and then on the upper part of the pancreas, to which it gives several branches, and divides in the notch of the spleen, into five or six branches, which carry blood to every part of that organ.

A large artery is derived from this trunk, called the GASTRICA INFERIOR SINISTRA, which passes along the greater curvature of the stomach, and communicates with the gastrica dex-

tra. From this artery, the pancreas, omentum and mesocolon receive several small branches. There are *four or five branches* of the splenic artery, called *vasa brevia*, which are spent on the great left sac of the stomach, and anastomose with the branches of the left superior and left inferior gastric arteries.

The HEPATIC BRANCH of the CŒLIAC ARTERY, is less than the splenic artery, and is concealed by the pancreas. It passes forwards and upwards behind the lesser curvature of the stomach, pylorus, and duodenum; and, near to the neck of the gall-bladder, divides into the *Gastrica Inferior dextra*, and the proper *Hepatic Artery*. This artery, in the capsule of Glysson, is situated between the vena portæ and ductus communis choledochus. Many persons experience a pulsation in the region of the stomach, which proves very alarming to them: this, according to MORGAGNI *, is owing to an enlargement of the heart, which descends lower than usual, pressing before it the diaphragm, and forcing forwards the liver. This pulsation is often unconnected with any organic disease in any part of the arterial system, and proceeds from the pulsation being communicated from the subjacent artery to a tumour that lies over it; which tumour is often occasioned by an enlargement of the lacteal glands at the root of the mesentery.

From the gastrica dextra, the following branches are derived:

The *Arteria Pylorica*, which supplies the pylorus: The *duodenalis*, which is dispersed on the right portion of the duodenum: Small *branches* to the pancreas.

The trunk of the artery then passes along the great curvature of the stomach, and anastomoses with the arteria epiploica sinistra, a branch of the splenic artery.

The HEPATIC ARTERY, during its progress along the great curvature of the stomach, is subdivided into the following branches:

* Vide 17th Letter, Art. 28.

Branches to the *omentum ; branches* to the *stomach*, which anastomose with the superior gastric and pyloric arteries.

The *Right Branch* of the *Hepatic Artery*, before dipping into the substance of the liver, sends off branches to the gall-bladder, called the *Cystic*, which pass along the left side of the gall-bladder, and which are subdivided into a number of very minute branches upon the villous coat of the gall-bladder.

Deviations as to the distribution of the larger branches of the abdominal aorta are very rare. I have met with an instance in which the superior gastric hepatic or splenic arteries came off separately from the aorta. In this instance, these vessels were of the usual size, and their smaller branches followed their usual course.

Of the Superior Mesenteric Artery.

The SUPERIOR MESENTERIC ARTERY, which is equal in some to the cœliac artery, takes its rise from the fore-part of the aorta, about a quarter of an inch below the cœliac: it is concealed by the pancreas.

This artery passes over the duodenum, and is situated between the layers of the mesentery; it turns from the left side of the spine towards the right, forming an arch. From the left or convex side of the arch, *twenty* or *thirty large branches* are sent; each of which divides into two branches, which communicate with each other, and form arches; from the convex part of these, still smaller arteries are derived, which anastomose in a similar manner.

There is a similar junction and separation of the smaller branches: at length the branches are straight, which pass to the intestines, and which, upon the villous coat, are subdivided into very minute branches, terminating upon the villi.

There are *several small branches* of this artery sent to the posterior part of the pancreas, which afterwards supply the duodenum, and anastomose with the branches of the cœliac.

There are two or three small branches of this artery, which are spent upon the lower and left flexure of the duodenum.

The larger branches of this artery on the left side convey blood to the *jejunum* and *ileum;* and these branches anastomose with each other by transverse arches.

The larger branches of this artery on the right side are placed between the layers of the mesocolon, and have been named,

1*st*, The COLICA MEDIA, which supplies the middle of the transverse arch of the colon, takes its rise under the duplicature of the mesocolon: and the left branch of this artery communicates with the colica sinistra, and inferior mesenteric artery.

2*d*, The *Dextra*; by means of which the right side of the colon is supplied with blood. This vessel anastomoses with the colica media, and there are many small branches sent off from this artery.

3*d*, *Small branches*, which are distributed on the omentum, and communicate with the arteriæ gastro-epiploicæ.

4*th*, The ILEO-COLIC, which supplies that part of the ileum which terminates in the colon; and from which a branch is derived, which communicates with the colica dextra.

A branch of this artery supplies the appendix vermiformis.

Of the Inferior Mesenteric Artery.

The INFERIOR MESENTERIC ARTERY is smaller than the superior mesenteric. This artery takes its rise from the left side of the aorta, between the renal arteries and iliacæ communes: it descends behind the peritonæum to the left side, upon the psoas muscle, and soon divides into an ascending branch, and the *left colic artery:* the former supplies the colon with blood; and communicating with the colica media, forms the *great mesocolic arch*: the latter supplies the sigmoid flexure of the colon, called *Hæmorrhoidalis Interna.* The continuation of the trunk of the artery descends behind the back part of the intestinum rectum, which it supplies with blood.

A ligature may be thrown around the abdominal aorta, and

yet the flow of blood to the inferior extremities is not obstructed.

Sir A. Cooper was so polite as to send to me the body of a dog, whose aorta had been obstructed by a ligature, about an inch and a half above its division into the iliacæ communes. In that instance, the anastomosing branch between the superior and inferior mesenteric arteries was much enlarged, and also the four superior lumbar arteries; and there were two large anastomoses between the second and third lumbar arteries.

Besides the branches that have been already named, the inferior mesenteric artery sends branches to the lower part of the colon.

Of the Corresponding Veins.

The veins correspond in their situation with the arteries above described, except the hepatic.

The large trunks of the veins, viz. the *Mesenteric*, the *Gastric*, and the *Splenic*, unite in forming a large venous trunk, which lies under the head of the pancreas, and then enters the liver at its portæ; and hence has been called the *Vena Portarum*. The vena portæ receives the *venæ cysticæ*, and then divides into two great branches; one of which supplies the right lobe, and the other the left lobe of the liver.

The blood carried to the liver by the hepatic artery and venæ portæ is returned to the heart by veins called *Venæ Cavæ Hepaticæ*, which open into the vena cava by two, and often by three trunks, where the vena cava perforates the diaphragm.

In a former part of this work, I have described some uncommon varieties as to the distribution of the vessels of the liver.

There is a preparation in the Museum, in which there is a very unusual distribution of veins of the abdomen.

The liver, which was taken from a person nineteen years of age, weighed only twenty ounces.

Two umbilical veins, each of them as large as the umbilical vein of a child at birth, were found running from the navel to the liver, near to which they joined, and formed one vein as large as the finger, which terminated in the left branch of the vena portæ.

On the outer side of the umbilical ring, the umbilical veins, communicated by large canals, with the subcutaneous veins, and with the epigastric veins, and so with the iliacæ communes veins.

For some time before death, the subcutaneous veins of the abdomen were much enlarged, and the patient had daily bloody stools.

Of the Renal Arteries.

These large arteries come off at right angles from the abdominal aorta, between the superior and inferior mesenteric arteries; and, in proportion to the organs on which they are distributed, they are of very considerable size. The branches of the *renal arteries* are not of the same length; the right is the longer, and passes behind the vena cava.

The *renal arteries* divide, before entering into the substance of the kidneys, into three or four large branches, which inclose the pelvis of this organ. These branches form arches, from which innumerable small branches are sent off to the outer or cortical part of the kidney. In a former part of this work, I have described the more minute branches of these arteries. The renal arteries send small branches to the fat that surrounds them, and to the renal glands. The veins of the kidney carry the blood back to the vena cava inferior. In some instances, the arteries of the renal capsule come off from the aorta, but in others, from the renal artery.

Of the Spermatic Arteries and Veins.

The SPERMATIC ARTERIES generally take their rise from the aorta, a little below the renal arteries; and sometimes from the renal arteries. They are about the size of a surgeon's probe,

and follow somewhat of a tortuous course, towards the pelvis, behind the peritonæum.

The spermatic arteries join the corresponding vein on the surface of the psoas muscle.

The spermatic arteries of the female are distributed upon the ovaria, uterus, and Fallopian tubes: they follow a tortuous course; and those of the uterus anastomose very freely with the uterine hypogastric arteries.

The first branches given off are those which are distributed on the fat around the kidneys and ureters, the colon, and the glands of the loins. The *spermatic arteries* of the male enter the upper aperture of the inguinal canal, where they are joined by the vasa deferentia: they follow the course of the inguinal canal; and, before reaching the testes, give off four or five branches, which are distributed upon the epidydimus and body of the testicle. The spermatic arteries of the bull follow a very tortuous and long route before reaching the testicle, which must certainly, in some manner, alter the nature of the semen.

In removing a diseased testicle, before dividing the spermatic cord, it was the practice of the older surgeons, with the view of stopping the bleeding from the branches of the *Spermatic Arteries*, to pass a ligature around the spermactic cord, which gives the most excruciating pain to the patient. Therefore, modern surgeons use no such broad ligature, but hold the portion of the divided cord between the finger and thumb of the left hand, and then dissect out the diseased testis; that being done, they take up the branches of the *Spermatic Artery* separately. This should be done by the operator himself, because, in giving the divided portion of the cord to an assistant, it may, by the action of the cremaster muscle, be drawn within the under abdominal aperture, and the patient may die from bleeding; and this may readily happen, when the cord has been divided very near to the under abdominal aperture.

Desault adopted a peculiar method of operating, when the disease extends high up in the spermatic cord. He dissected out the diseased testis, in the first place, from the scrotum; secured the bleeding vessels by ligatures; then pulled down

the cord, and laid hold of it between his finger and thumb; and then cut it through, above the seat of the disease: that being done, he took up the arteries of the cord separately. There is perhaps no operation in which a bleeding is so frequent as after castration, owing to the enlargement of the arteries and veins of the scrotum. I have seen surgeons secure, with great care, all the divided vessels they could see, after the testicle had been removed; notwithstanding which, after the patient had been in bed for two or three hours, so much blood was discharged as to render it absolutely necessary to undo all the dressings to stop the bleeding.

After the testicle has been removed, it is prudent, on the part of the surgeon, to postpone the dressing of the wound for some time.

It sometimes happens, that blood is effused from the branches of the spermatic artery within the body of the testes, or from a branch of the spermatic vein, or in consequence of blows, into the cellular substance of the scrotum. This constitutes the disease called *Hæmatocele.*

It sometimes happens that the spermatic cord is split by means of the protruded bowels, in cases of hernia, so that the vas deferens lies in front of the hernial tumour.

The *Veins* which accompany the branches of the spermatic arteries are much larger and more numerous than those of the arteries, and are provided with valves. These veins frequently become much enlarged; and, like a hernia, give a sensible impulse to the hand when the patient coughs.

This disease, which has been called *Circocele*, is usually limited to the veins of that part of the spermatic cord which is beneath the under abdominal aperture.

The swelling feels knotty and heavy when the patient is in the erect posture; and it becomes larger after exercise, after standing for some time, or forcible expirations; and sometimes it gives rise to a wasting of the testicle.

The next arteries which are sent off from the aorta are the *Lumbar Arteries.*

The lumbar arteries take their rise, in pairs, from the back-part of the aorta; the right are longer than the left, as they

pass under the vena cava; but, on some occasions, the lumbar arteries on both sides come off from the aorta by a single trunk. The lumbar arteries of the same side communicate. Anatomists differ as to the number of the lumbar arteries. HALLER enumerated six pairs, but most authors have reckoned five pairs only. All the lumbar arteries are situate behind the psoas and quadrate lumborum muscles. The lumbar arteries give branches to the spine, spinal marrow, muscles of the loins, the transverse and oblique muscles of the abdomen; and they communicate with the internal mammary, lower intercostal, diaphragmatic, epigastric, and circumflexa ossis ilii arteries.

SECTION IV.

OF THE COMMON ILIAC ARTERIES, AND THEIR BRANCHES.

The AORTA, opposite to the third lumbar vertebra, (but according to HALLER, opposite to the fourth lumbar vertebra), divides into two branches, which are, in the adult, very nearly of an equal size, and which have been termed *Common Iliac Arteries.* The common iliac arteries follow a similar course on the opposite sides of the pelvis. An artery, about the size of a surgeon's probe, arises from the bifurcation of the aorta, or from the iliac, which runs along the fore-part of the sacrum, as far as the lower extremity of the ossa coccygis. It has been called, from its situation, the *Sacra Media.* During its progress, it joins repeatedly with the sacræ laterales arteries, with which it forms anastomoses; and from these small branches are sent to the rectum and bladder of urine, and to the iliacus internus muscle.

The *right iliac artery* crosses over the lower part of the vena cava, and inclines to the outer side of the concomitant vein.

As there is a certain degree of resistance to the flow of the blood from the aorta to the common iliac arteries, this part of the arterial system is sometimes thrown into a diseased state.

The common iliac arteries sweep along the upper aperture

of the pelvis, having their concomitant veins on their inner side, or next to the contents of the pelvis; and, when nearly opposite to the sacro-iliac symphysis, they are divided into two large arteries, named the *Anterior* and *Posterior Iliac Arteries.* The former continues its course along the brim of the pelvis, but the latter sinks into the cavity of the pelvis, and divides into the umbilical, vesical, and pudendal branches.

Of the Branches of the Posterior Iliac or Hypogastric Artery.

This artery passes downwards and backwards for two inches. It is larger than the anterior iliac artery in the adult, and much more so in the fœtus.

The first branches sent off have been called the *Ilio-Lumbar Arteries.* These take their rise from the back part of the parent trunk, and they are concealed between the psoas and internal iliac muscles. They give off several small branches to the psoas muscles, and the lowest vertebra of the loins.

There are commonly *four Sacro-Lateral Arteries*, which come off from the posterior iliac arteries, from the gluteal, and sometimes from the ilio-lumbar arteries.

The branches of these arteries communicate with the sacro-media artery. There are other branches which enter the foramina of the sacrum, and are distributed upon the cauda equina; and branches of this artery communicate with the superior arteries of the spinal cord.

The next considerable branch is the UMBILICAL *Artery.* This artery passes down as far as the lowest part of the bladder. It is then reflected, and ascends along the side of the bladder, with which it is connected by cellular substance. It is directed upwards to the navel; and, in the adult, is generally quite impervious; but for the space of one or two inches in that part of the artery which remains open, *three or four smaller arteries* are sent to the bladder of urine, and there are *very small branches* which go to the sides of the rectum.

From the arteries common *to the bladder of urine*, small arteries are sent to the vesiculæ seminales and prostate gland,

which anastomose with the deep-seated branches of the pudic artery. The artery at length terminates in the navel.

The next considerable branch has been called the HÆMORRHOIDEA MEDIA. It is often awanting. This artery sometimes takes its origin from the posterior iliac, or pudic artery. It passes along the anterior surface of the rectum, as far as the sphyncter ani.

This artery divides into numerous small branches, which are spent upon the rectum, and which anastomose with an artery of the same name, which is derived from the inferior mesenteric artery.

A few small branches of this artery are spent upon the bladder of urine, vesiculæ seminales, and prostate gland.

This artery has sometimes been wounded in performing the lateral operation for lithotomy, and also in cases of fistulæ which are situated very high up within the rectum.

The next considerable branch is the UTERINE HYPOGASTRIC artery. This artery, which arises from the pudic, umbilical or hæmorrhoidal, passes between the laminæ of the broad ligaments to the posterior surface of the uterus, and it anastomoses freely with the spermatic arteries. Upon the inner side of the gravid womb, the smaller branches of this artery may be observed, after they have been filled by injection, disposed like the worm of a cork-screw.

The *Vesical Arteries* are also derived from the posterior iliac arteries, and generally in common with the umbilical, the root of which remains pervious even in the adult.

The OBTURATOR *Artery* commonly arises from the posterior iliac artery; but sometimes takes its origin in common with the epigastric artery, from the anterior iliac, and sometimes from the ischiatic artery.

The trunk common to the *obturator* and *epigastric arteries*, is sometimes a quarter of an inch in length; in other instances, it measures from an inch to an inch and a half, and I have met with it of all intermediate lengths.

If the common trunk be only a fourth of an inch long, the *obturator artery* runs on that side of the sac which is next to the anterior spinous process of the ilium, and cannot be dis-

placed, being firmly bound down by cellular substance: it cannot, therefore, be injured in that kind of crural hernia, in which the displaced bowels are lodged within the sheath of the lymphatic vessels, by dividing that part of the crural arch next the pubes, in the manner recommended by Mr GIMBERNAT.

On the other hand, it frequently happens, when the *obturator* arises in common with the epigastric artery, that a third branch, nearly of equal size with the *obturator*, takes its rise from the common trunk. This may be called the artery of the internal part of the crural arch; for it runs on the inner side of the crural arch, passes across GIMBERNAT's Ligament, and, when it reaches the symphysis pubis, divides into a number of small branches which are distributed upon the inner side of the symphysis pubis.

When the trunk common to the *obturator* and *epigastric arteries* is an inch, or an inch and a half, in length, the *obturator artery* is situated between the symphysis pubis and the hernial sac, and sometimes follows the same course as that part of the crural arch called GIMBERNAT's Ligament, of which arterial distribution I have seen several examples.

Mr JAMES WARDROP, was, I believe, the first who described such a distribution of arteries in the case of crural hernia. In the instance alluded to, the *obturator artery* arose from the same trunk as the *epigastric artery;* then passed on the pubal side of the neck of the hernial sac, and described a semicircle around the neck of the sac.

There is little risk of wounding the obturator artery, excepting when the trunk common to it and the epigastric, is an inch long, and when it follows the course of GIMBERNAT's ligament: hence that unusual deviation of the obturator artery from its ordinary course, does not form so strong an objection to GIMBERNAT's operation for crural hernia as has been stated.

There is still another variety as to the distribution *of the epigastric and obturator arteries.* These arteries in some cases come off from the anterior iliac artery by separate trunks; and *the obturator artery passes around that part of the cru-*

ral arch called GIMBERNAT'S *Ligament*, and is attached to it by cellular substance. When this happens, the obturator artery, by the descent of a portion of the intestine through the crural ring, is pressed upon the very part of the crural arch divided by GIMBERNAT in his operation for crural hernia.

In some cases I have seen the *obturator artery* sent off from the external iliac artery, about an inch and a half above, and in others, about an inch below, the *epigastric artery*. In still other instances, the obturator arises from the *superficial femoral artery*; and ascends along the pectineus muscle, entering the pelvis at the crural aperture. The artery in this case is placed behind the crural hernia.

I have seen, in one instance, two obturator arteries, the one of which took its rise from the hypogastric artery, and the other arose from a trunk which was common to it and the epigastric, and both obturator arteries were united before passing through the foramen obturatorum.

I have made particular mention of all the varieties as to the origin of the obturator arteries which have fallen under my observation, as these arteries are of considerable size, and, when divided in the time of performing the operation for crural hernia, have sometimes poured out so much blood as to prove fatal; for, on account of their deep situation and retraction, it is very difficult to secure these vessels by ligature.

The obturator artery gives branches to the levator ani, iliacus internus and psoas muscles: frequently there is a branch which passes across the symphysis pubis, and which anastomoses with a branch of that artery of the opposite side.

When this artery has passed through the foramen obturatorum, it gets between the acetabulum and tuber ischii, and gives out several branches to the obturator internus and externus muscles, and to the adductor maximus; it anastomoses with the internal branch of the circumflex artery, which is derived from the profunda femoris.

The artery then divides into external and internal branches, which are spent on the lower part of the bladder of urine, the vesiculæ seminales, and prostate gland, and communicate

with the pudendal artery. The external branch is distributed on the obturator muscles, the ligament of the hip-joint, and origin of the vastus internus muscle.

The next large artery which is sent off from the posterior iliac artery is the GLUTEAL ARTERY. This artery is placed under the gluteus maximus and medius muscles; it passes over the pyriform muscle, and between it and the inferior edge of the ileum which forms the upper part of the sciatic notch.

This artery has sometimes been opened by a wound inflicted by a cutting instrument; and it is required, in order to stop the bleeding, to throw a ligature around the main trunk. A case of this description occurred in the hospital of this city, and was ably treated by Mr J. BELL.

This is the largest branch of the posterior iliac; it takes its rise from the back-part of the trunk of the posterior iliac, passes backwards through the uppermost part of the great notch of the os ilium, and is subdivided into two great branches, a *superficial*, and *a deep-seated branch*, which anastomose with each other.

The superficial passes between the gluteus maximus and medius, and pyriform muscles, to both of which it gives many branches. This artery anastomoses with the sacral artery.

The deep-seated branch, placed under the middle of the gluteus muscle, divides into superior and inferior branches.

The branches of the superior are distributed on the dorsum of the os ilium and the gluteus medius muscles, and some small branches pass downwards on the gluteus minimus muscle.

The inferior branch is distributed upon the inferior gluteus, superior geminus muscle, and subdivides suddenly into a number of small branches, which are lost upon the trochanter major, and which inosculate with the smaller ascending branches derived from the perforating branches of the arteria profunda femoris.

The ISCHIATIC ARTERY is also a large branch of the posterior iliac. This artery leaves the pelvis at the lower margin of the pyriform muscle and the superior sacro-sciatic ligament;

the artery lies under the gluteus maximus muscle, and is accompanied by the sciatic nerve.

This artery sends branches to the tuberosity of the ischium, which anastomose with the pudic, and is covered by the gluteus maximus muscle. It descends in the hollow between the great trochanter of the thigh-bone and the tuberosity of the ischium, along with the sciatic nerve.

Before leaving the pelvis, it detaches branches to the intestinum curvum, the womb, bladder, obturator internus, and pyriform muscles; and, without the pelvis, it detaches the arteria coccygea, which passes along the posterior sacro-sciatic ligament, and gives branches to the levator ani, coccygeus muscle, the fat and bones of the coccyx.

The next branch sent off is the PUDIC ARTERY.

This artery is derived from the hypogastric, or from the ischiatic artery. This artery passes between the pyriform muscle and the posterior part of the levator ani muscle. The artery passes through the under part of the great sciatic notch, and then between the sacro-ischiatic ligaments to the spine of the ischium. The artery then runs towards the inner surface of the tuberosity of the ischium, to which it is fixed by the tendinous aponeurosis of the obturator internus muscle. The artery then advances along the inner side of the ascending ramus of the ischium, behind the transversalis muscle and crus penis. In the above course, there are several small branches sent off, which supply the bladder of urine, vesiculæ seminales, the obturator internus muscle, the pyriform and gluteus maximus muscles, and the external hæmorrhoidal branches. Branches of the same artery pass to the origins of the triceps adductor femoris and semitendinosus muscles.

The following branches are sent off from the ascending branch of the pudic artery.

1. The PERINÆAL ARTERY ascends between the accelerator urinæ and erector muscles, supplying with blood the fatty muscles, skin of the perinæum, and scrotum.

2. The PROFUNDA PENIS, which is placed under the transversalis perinei. It is fixed to the ascending branch of the ischium, and having reached the symphysis pubis, where

the corpora cavernosa penis are united, it is subdivided into two great branches, one of which passes along the dorsum of the penis, through the whole length of that organ, immediately beneath the skin; and, in that course, it is subdivided into a great many small branches, which are distributed on the corpora cavernosa penis, and on the glans penis.

The deeper branch of this artery subdivides into the *arteries proper to the corpora cavernosa penis, and corpus spongiosum urethræ;* and those of opposite sides inosculate with each other through the septum penis.

Compression is not to be relied upon after the penis has been amputated; the ligature is indispensable. Mr HEY has pointed out the necessity of securing the several arteries of the penis by the ligature, and has also strongly recommended the encircling the sound part of the penis by a broad piece of tape; it forms a useful kind of tourniquet during the operation, and prevents the loss of blood during the time the surgeon is engaged in putting his ligatures upon the divided vessels.

It is not necessary to pass a tube into the urethra. I have seen cases terminate well without it. All that is necessary is occasionally to pass a bougie.

Mr A. BURNS shewed me two specimens, in which the pudic artery, instead of passing out of the pelvis between the sacro-sciatic ligaments, passed along the lateral and inferior part of the bladder, and traversed the upper part of the prostate gland, in its course to the ramus of the os ischium.

I have not seen on any occasion, such a considerable quantity of blood lost during the lateral operation of lithotomy, as was at all dangerous. The bleeding proceeds from cutting into the bulb, by which the branch of the pudic artery which is proper to the bulb is divided, and the large trunk proper to the corpus cavernosum. In the female, a branch of this artery is sent between the sphyncter vaginæ and erector clitoridis to the body of the clitoris.

The next artery which is sent off from the anterior iliac, at an acute angle, has been called the EPIGASTRIC.

There is much variety as to the origin of the epigastric artery: generally it takes its rise about an inch from the cru-

ral arch; it is then reflected upwards and inwards behind the spermatic cord, and on the inner side of the upper abdominal aperture. The artery then passes behind the rectus abdominis muscle, and ascends to meet with the smaller branches of the internal mammary artery, upon the back-part of the rectus abdominis.

In the female, a branch of this artery passes along the round ligament of the womb, and there are branches of it which go to the mons veneris and labia pudendi.

The epigastric artery sends a small branch, which is distributed upon the pubal side of GIMBERNAT's ligament; a second, which passes through the inguinal canal; a third to the spermatic cord, which communicates with the spermatic artery, behind the peritonæum.

In the common inguinal hernia, the epigastric artery is placed nearer to the symphysis pubis than the protruded bowels, and, by the displaced bowels, is pressed still nearer to it: but when the bowels do not follow the whole course of the inguinal canal, but pass through the under abdominal aperture only, as in the *ventro-inguinal hernia*, the epigastric artery is between the spine of the ilium and the protruded bowels: hence, if the incision for the removal of the stricture be made on the pubal side of the hernia, the epigastric artery will be divided, if the hernia be the common inguinal; and if, on the other hand, the incision for taking off the stricture be made on the ileal side of the tumour, the epigastric artery will probably be divided, if it be a ventro-inguinal hernia. As during life there is a difficulty in distinguishing the common from the more rare ventro-inguinal hernia; hence, the greater safety of making the incision for taking off the stricture in the middle of the neck of the hernial tumour.

Many small branches of this artery are distributed upon the integuments of the abdomen, which sink into the substance of the recti and other muscles of the abdomen; and anastomose with the thoracic, intercostal, and lumbar arteries.

CIRCUMFLEX *Artery of the Ilium.*—This artery arises opposite to the epigastric artery; runs along the internal edge of the crural arch, under the peritonæum: follows a retro-

grade course, and reaches the spine of the os ilium; and, as it ascends, divides into branches, which supply the internal oblique and transverse muscles of the abdomen, and communicate with the lumbar and ilio-lumbar arteries, and with the inguinal branch of the arteria profunda femoris.

This artery also gives branches to the psoas, sartorius and iliacus internus muscles, and small branches to the inguinal lymphatic glands.

Of the Femoral Artery and its Branches.

The femoral artery, covered by the fascia lata, surrounded by fat and the lymphatic glands of the groin, lies over the ball of the thigh-bone, and covers the corresponding vein; is afterwards lodged in the hollow at the upper and inner part of the thigh, having the adducter muscles on the inner side, and the rectus and sartorius on its other side.

There are large anastomoses between the branches of the anterior and posterior iliac arteries, by the branches of the gluteal, internal pudendal, obturator, and ischiatic arteries; hence a ligature may be thrown around the anterior iliac artery, without a risk of gangrene following. Mr Abernethy, in the year 1796, took up the external iliac artery. His two first cases terminated fatally: they however proved, that the want of success was not to be attributed to the want of a due supply of blood.

In his surgical works, vol. i. p. 242., he has thus described his mode of operating:

"I first made an incision, about three inches in length, through the integuments of the abdomen, in the direction of the artery, and thus laid bare the aponeurosis of the external oblique muscle, which I next divided from its connection with Poupart's ligament in the direction of the external wound, for the extent of about two inches. The margins of the internal oblique and transverse muscles being thus exposed, I introduced my finger beneath them for the protection of the peritonæum, and then divided them. Next with my hand I pushed the peritonæum and its contents, upwards and inwards, and took hold of the external iliac artery with my fin-

ger and thumb; so that I was thus enabled to command the flow of blood from the wound. It now only remained that I should pass a ligature around the artery and tie it, but this required caution, on account of the contiguity of the vein to the artery. I could not see the vessels, but I made a separation between them with my fingers. Having, however, only a common needle, with which to pass the ligature, I several times withdrew the point, from the apprehension of wounding the vein. After having tied the artery about an inch and a half above POUPART's ligament, I divided that part, and thus laid the new and the former wound into one."

The first artery derived from the superficial femoral artery, is the superior EXTERNAL PUDIC which crosses the heads of the pectineus and gracilis muscles, and gives branches to the inguinal glands, to the scrotum, and anastomoses with the branches of the epigastric artery. The small branch of this artery proper to the scrotum, in some cases of large scrotal herniæ, attains a large size. In the female, branches of this artery are spent on the labia pudendi.

A little lower down, the INFERIOR PUDIC ARTERY takes its rise, which crosses the pectineus muscle, and the heads of the adductor longus and gracilis.

These pudic arteries anastomose with the arteria pudenda, the obturator, and spermatic: several of the branches of the pudic arteries anastomose with those of the penis.

About two inches under the crural arch, the femoral artery commonly divides into two great branches, which are nearly equal in size. The branch which follows the same direction with the trunk, has been called the ANTERIOR SUPERFICIAL FEMORAL ARTERY, and the other, which sinks deep among the muscles, and is concealed by fat and glands, and by the trunk of the superficial femoral, is called the ARTERIA PROFUNDA FEMORIS. In a few instances the arteria profunda femoris is sent off immediately under POUPART's ligament.

The trunk of the superficial femoral artery descends obliquely towards the inner side of the thigh; gradually sinking deeper as it descends; and, about the middle of the thigh, is situated on the triangular space between the vastus internus

muscle and the second head of the adductor muscle; and the sartorius muscle passes across it. This artery is by no means uniformly of the same size.

The arteria profunda femoris is covered at its origin, by the superficial femoral artery, and by the glands of the groin: it is placed in the hollow between the pectineus and adductor muscles of the thigh. It then inclines towards the inner side of the thigh, after giving off the circumflex arteries, and is lodged in the cavity between the second head of the adductor muscle, and the vastus internus muscle, in which place it descends as far as the middle of the thigh.

The following branches are derived from the arteria profunda femoris:—a small branch which is spent chiefly on the rectus femoris, iliacus internus, and on the skin of the upper and inner parts of the thigh.

The EXTERNAL CIRCUMFLEX which passes under the sartorius and rectus muscles, and towards the root of the great trochanter, is distributed on the rectus cruris; and, perforating the fascia of the thigh, is spent on the skin over the hip. A large branch passes down the inside of the vastus internus, and communicates with the superior articular artery of the knee. The circumflex artery sometimes takes its rise from the superficial femoral artery.

The INTERNAL CIRCUMFLEX takes its rise nearer to the external circumflex, from the inner and back part of the trunk of the profunda; sinks deep between the pectineus iliacus internus, and psoas muscles; it then passes into the space between the greater and lesser trochanter. The artery gives branches to the neck of the thigh-bone, acetabulum, and obturator externus muscles.

An *external pudic artery* is sometimes derived from the internal circumflex, but more commonly from the superficial femoral artery.

This artery crosses the upper portions of the pectineus and gracilis muscle, and is subdivided into a number of small branches, which are distributed upon the inguinal glands, the scrotum, and pubis.

A branch of this artery anastomoses with a branch of the

obturator artery. Small branches of this artery also anastomose, upon the capsular ligament of the hip-joint, with those of the gluteal artery.

The internal circumflex then passes behind the lesser trochanter, and is subdivided into many small branches, some of which sink into the substance of the triceps adductor femoris, others supply the quadratus femoris, and obturator internus muscles.

A descending branch of this artery passes outwards from beneath the quadratus femoris, anastomoses with the branches of the ischiatic artery, and terminates upon the semimembranosus, semitendinosus, and adductor muscles.

The circumflex arteries also anastomose with the arteries of the periosteum.

The branches proper to the periosteum, are derived from the external circumflex, which enters the cruralis muscle, and which anastomose with other branches which come under the vastus internus muscle.

About the middle of the thigh; a considerable branch is derived from the arteria profunda, which is distributed upon the periosteum, and which divides into ascending and descending branches; the former of which join with the smaller branches of the external circumflex artery, and the latter with the superior articulating branches of the popliteal artery; and also with a branch derived from the popliteal artery, which is distributed upon the periosteum, covering that part of the thigh-bone in the vicinity of the condyles.

In a patient operated upon by Sir A. Cooper, for popliteal aneurism, the femoral artery was converted into a cord, from the origin of the arteria profunda, down to the ham. The arteria profunda was considerably enlarged; it followed its usual course to the back of the thigh, and sent branches, of a larger size than usual, to the flexor muscles; and those branches which accompany the sciatic nerve, were the principal supporters of the new circulation. They were five in number.

The external circumflex artery was considerably larger than usual, for the supply of branches to the muscles on the

fore part of the thigh. No vessels capable of receiving coarse injection could be traced between the obturator, ischiatic, and arteria profunda femoris.

Since my "Outlines of Anatomy" were published, I have met with a distribution of the arteries, which, as far as I know, has not been described. A branch, about the size of a writing pen, was sent off from the femoral artery immediately after its exit from the pelvis: this branch ran down in a direction paralel to that of the femoral for the space of three inches; then passed along the inner side of the rectus cruris for some way, and afterwards divided into small branches, which dipped into the substance of that muscle. The internal and external circumflex and arteria profunda femoris were sent off as usual.

There are *four perforating arteries*, derived from the profunda femoris.

The first *perforating artery* arises below the trochanter major; and, after having passed through the adductor muscle, appears on the back thigh, about two inches below the quadratus femoris, and divides into two branches; one of which runs upwards to the great trochanter, is subdivided into small branches upon the gluteus maximus muscle, and anastomoses with the smaller branches of the gluteal artery. The other branch passes into the substance of the vastus externus muscle, and anastomoses with the smaller ramifications of the external circumflex artery.

Dr Ryan made for me a very beautiful preparation of the arteries above described, in which the superior branch of the profunda ascended upon the posterior part of the long head of the biceps flexor cruris, and divided into two small branches, which inosculate with two similar branches of the ischiatic artery, so that, upon the above mentioned muscle, *an arterial circle is formed* by the conjoined branches of the ischiatic and superior perforating branch of the profunda femoris.

In this preparation, there was *another arterial circle* formed upon the dorsum of the os ilium, immediately above the ace-

tabulum, by the conjoined branches of the external circumflex artery, and a small gluteal artery.

I have made the more particular mention of these *arterial circles*, or as they may be called *Double Anastomoses*, found in the above described case, as SCARPA has not represented such arterial circles in his very splendid and accurate plates of the arteries of the head, neck, superior and inferior extremities.

In most cases, the perforating branches come off separately; but, in other instances, I have seen them derived from a common trunk.

The second *perforating branch* is the continuation of the trunk of the artery: it passes through the adductor maximus muscle, near to the linea aspera, and also to the shorter head of the biceps muscle, and divides into a number of small branches, which are distributed upon the biceps flexor cruris.

This artery also gives branches to the vastus internus, and to the long adductor of the thigh; and it sends upwards a branch which anastomoses with the first perforant.

The third *perforating artery* passes over the short head of the biceps flexor cruris, and afterwards dips into the substance of the vastus externus, and anastomoses with the branches of the external circumflex muscle.

The branches of the fourth *perforating artery* are distributed upon both heads of the biceps; and some of its branches are distributed upon the semitendinosus, and semimembranosus muscles.

About two-thirds down the thigh, the trunk of the superficial femoral passes obliquely backwards between the tendon of the adductor magnus and the thigh-bone: it reaches the back part of the thigh-bone, then descends into the ham, where it lies on the flat part of the thigh-bone, and is covered by the corresponding vein and the sciatic nerve, and is well protected by the condyles of the thigh-bones and a quantity of fat and cellular substance.

Of the Popliteal Artery.

This artery is placed between the outer and inner ham-

strings, and lies upon a flat portion of the thigh-bone between its condyles. It is covered by the corresponding vein and popliteal nerve; the latter lies most superficially.

There are five branches of the popliteal artery, called its ARTICULAR BRANCHES, three of which are placed on the inner, and two on the outer side of the knee-joint. These branches anastomose with each other, and with the branches of the arteria profunda femoris, and also with those of the superficial femoral artery.

The first branch of the popliteal artery ascends from the ham towards the inner and lower part of the thigh, and is lost in the vastus internus muscle, by which it is covered: it sends small branches to the capsular ligament of the joint, and it anastomoses with the other articular arteries, and with the branches of the superficial femoral.

The second branch, called *Superior Internal Articular Artery*, descends to the inner condyle of the thigh-bone, and anastomoses with the external articular artery.

This artery afterwards divides into *two branches;* one of which passes over the capsular ligament of the knee-joint, and assists in forming a net-work of bloodvessels which covers the patella; a still smaller branch passes on the edge of the internal semilunar cartilage, and enters the cavity of the knee-joint.

The deeper-seated branch passes along the capsular ligament, and divides into a number of small arteries, which enter the internal condyle of the thigh.

The *Inferior Internal Articular Artery* ascends to the inner condyle of the thigh-bone, under the internal lateral ligament, to the lower part of the knee-pan, and is covered by the tendinous aponeurosis of the semimembranosus, sartorius, and semitendinosus muscles; and it anastomoses with the preceding artery.

There are also two *external articular arteries*, a superior and an inferior, derived from the popliteal artery: the former supplies the muscles in the vicinity of the outer condyle of the thigh-bone and the external lateral ligament; the latter, which, at its origin, is covered by the gastrocnemius muscle, becomes

more superficial at the head of the fibula, sends a few small branches to the cavity of the joint, and anastomoses with the superior external, and superior internal, articular artery, under the ligament of the patella.

The fifth articular artery has been called the *Arteria Media:* it is situated between the condyles of the thigh-bones, and suddenly subdivides into many small branches, which are distributed upon the capsular ligament and fat of the posterior part of the knee-joint.

As the femoral and popliteal arteries are covered by fat, cellular substance, and lymphatic glands, if these shall fall into a state of suppuration, they receive pulsation from the subjacent artery, and the tumour may be mistaken for an aneurism.

An aneurism which has recently appeared, becomes flaccid when the flow of blood to it is intercepted by pressure between it and the heart, and the bulk of the tumour is materially lessened; and upon the pressure being taken off, the tumour regains its former bulk: on the other hand, if the pressure be made below the aneurism, the tumour becomes still more tense, and the pulsation of it is more violent.

If the pulsation of a tumour be derived from a subjacent artery, it ceases as soon as the tumour is pulled away from that artery; but when a tumour acquires a pulsation from an artery passing through it, the diagnosis is difficult.

On account of the impediment to the free flow of blood presented by the arch, described by the popliteal artery, when the knee is bent, and the circulation at the same time accelerated, that artery is apt to fall into a morbid state; hence the greater frequency of popliteal aneurism amongst coachmen, dragoons and others who ride on horseback.

The situation of the artery, in respect to the accompanying vein and artery, affords a ready explanation of the symptoms that characterise this aneurism, and of the consequences of it.

The accompanying nerve is elevated, and put upon the stretch, and is the cause of the pain which the patient experiences in the knee.

When the tumour has attained a considerable size, the leg

becomes œdematous, the free return of the blood being interrupted by the aneurism; and, from the continued pressure of the tumour on the thigh-bone, this bone is often thrown into a carious state, when the disease has been of considerable duration.

Mr J. Hunter, in the year 1785, proposed his improved method of treating this disorder, to which he was led by the expectation of removing the disease, by preventing the blood from reaching the tumour, by a ligature thrown around the femoral artery, the coats of which are probably sound, and therefore disposed to unite in a kindly manner; whereas those of the popliteal artery being diseased, do not unite, and a bleeding ensues when the ligature has been removed.

Mr Hunter was also well aware, that there was little risk of gangrene ensuing, though a ligature was thrown upon the main trunks of the artery, as the circulation would still be maintained through the medium of the lateral anastomosing arteries.

Of late, an improved method of applying the ligature has been introduced, in consequence of the observations of Dr Jones, who has proved, that a secondary hæmorrhage is occasioned by the application of four ligatures. The vasa vasorum, proper to the portion of the artery included within the ligature, are cut off; the included portion being deprived of blood, therefore falls into a state of gangrene, and the patient is exhausted by repeated bleeding: one ligature only is now employed, or at most two, and the artery is divided between them, according to the method of Mr Abernethy.

In consequence of the application of the ligature, the tumour in the ham ceases to be painful, and to pulsate; it shrinks; its contents are absorbed; and in the space of a few weeks, in the site of the tumour, a tense cord only can be felt.

The operation may be performed as follows. The patient is to be laid in the horizontal posture; an incision four inches long is to be made, about half way between the anterior spinous process of the os ilium and the upper edge of the knee-pan, where the sartorius muscle crosses the thigh, and on the inner side of that muscle.

The muscle is then to be drawn aside; and if the point of the finger be introduced into the bottom of the wound, *the pulsation of the artery may sometimes, but not always, be distinguished.* I have said *sometimes*, for I have seen the pulsation of the femoral artery cease when it has been laid bare.

The fascia is then to be divided, and the cellular sheath of the artery. The femoral vein and crural nerve are to be carefully separated from each other, and a ligature is then to be applied to the artery; which being done, the lips of the wound should be brought together by adhesive straps.

Scarpa has lately recommended, that the operation for femoral artery should be performed in the upper third of the thigh, in order to avoid displacing the sartorius muscle, (which sometimes has occasioned considerable embarrassment), and as the artery in that situation is more superficial.

I have seen this method of operating put into practice, and consider it to be the preferable; but it is liable to the objection, that, in case of a secondary bleeding, it is not so easy to re-apply the ligature, as when the operation has been performed according to Mr J. Hunter's method.

The popliteal artery descends between the heads of the gastrocnemii muscles, to which it gives several branches, called *sural;* and, opposite to the under edge of the popliteus muscle, it divides into two large branches, the tibialis postica and antica.

The anterior tibial artery arises from the popliteal artery, at the lower edge of the popliteus muscle, and it immediately perforates the upper part of the interosseous ligament; descends along the anterior surface of it, between the tibialis anticus, and extensor digitorum longus muscles, about the middle of the leg; it crosses over the tendon of the extensor proprius pollicis pedis, and the tendon of the long extensor of the toes. Above the ancle, it is situated upon the forepart of the tibia; it then passes under the annular ligament; then between the extensor longus pollicis and tibialis anticus muscle; and passing along the upper part of the foot, at the root of the first metatarsal bone, it passes through to the sole of the foot, between the metatarsal bone of the great toe, and

and that next to it, and communicates with the external plantar artery.

This artery is very constant in its course. But I once had occasion to see an instance, in which that artery passed along the side of the upper part of the foot, and communicated first with the fibular artery, and then passed between the metatarsal lines of the little toe, and that next to it, and communicated with the external plantar artery.

This artery usually gives off the following branches: the *recurrent*, after it has passed through the interosseous ligament, which is spent upon the muscles of the upper part of the leg, and which anastomoses with the inferior articulating artery of the knee-joint: A number of *small branches to the muscles* on the fore part of the leg: The *external* and *internal malleolar arteries*, which supply the ancle-joint and neighbouring part of the tarsus; the latter of which anastomoses with the posterior and peroneal artery: The *tarsal arteries*, which run along the extensor digitorum brevis: The *metatarsal artery*, which runs towards the root of the little toe, and sends off those small branches which supply the interosseous muscles.

The continuation of the artery proceeds between the extensors of the great and smaller toes; and the principal part of the artery passes to the sole of the foot, between the metatarsal bones of the great and second toes.

There are a few branches detached from the artery before it reaches the sole of the foot, which are distributed upon the metatarsal bones of the toes.

The POSTERIOR TIBIAL ARTERY is situated under the origin of the soleus muscle; passes to the lower part of the tibia; and then divides, about an inch below the rise of the tibialis antica, into the Tibial and Fibular arteries.

The FIBULAR is the smaller of these branches; it runs down the leg along the fibula, between the tibialis posticus, and flexor longus pollicis; and, near to the bottom of the leg, divides into the anterior and posterior peroneal branches. The PERONEA ANTERIOR passes through the interosseous ligament, and communicates with the external malleolar arteries. The *pe-*

ronea posterior descends behind the external malleolus to the outer and back part of the foot, and anastomoses with the external malleolar and external plantar arteries.

The posterior tibial artery, placed between the tibialis posticus and flexor communis digitorum, follows the course of the tibia to the lower end of that bone; and becoming more superficial, is situated between the inner ancle and the tendo Achillis.

There are several small branches detached from the posterior tibial artery and sent to the adjacent muscles; and also several small branches to the os calcis, which communicate with the smaller branches of the anterior tibial artery.

The trunk of the artery then passes to the sole of the foot; and before passing behind the abductor pollicis, divides into the *Internal* and *External Plantar Arteries.*

The INTERNAL PLANTAR ARTERY is placed on the inner side of the foot, between the tendon of the tibialis posticus muscle and the origin of the abductor pollicis and tendinous aponeurosis of the sole.

From this artery, several small branches are detached, which are proper to the muscles and integuments of the sole of the foot.

This artery passes under the flexor longus pollicis pedis, anastomoses with the plantar arch, and gives a branch, which supplies the outer side of the great toe, and inner side of the toe next to it.

The PLANTARIS EXTERNA, which is larger than the internal plantar artery, passes between the flexor brevis digitorum pedis, and flexor accessorius, till it reaches the metatarsal bone of the little toe. It then inclines inwards, to the basis of the metatarsal bone of the little toe.

This artery detaches a branch to the under and outer part of the heel, which communicates with the branches of the anterior tibial and fibular arteries; and also sends several branches to the flexor muscles of the toes.

This artery forms an arch between the flexor muscles, the metatarsal bones of the small toes, and the root of the great

toe; and from that arch, branches are sent to the interossei muscles; also three large digital branches, each ofwhich, at the root of the toes, divides into two branches, supplying each side of the toes; and these, at the points of the toes, are united.

The perforating branch of the anterior tibial artery, joins the plantar arch, so as to form a free communication between the arteries of the upper and under side of the foot.

SECTION V.

OF THE VEINS OF THE INFERIOR EXTREMITIES.

The coats of the veins of the inferior extremities, are thicker than those of the veins of the superior extremities; and, in some instauces, they attain so great a thickness, as to bear a very strong resemblance to those of an artery.

The veins, especially the subcutaneous, of the inferior extremities, are neither so large nor so numerous as those of the superior extremities; and in the veins of the inferior as in those of the superior extremities, there are many pairs of valves.

There are two sets of veins in the inferior extremities; a *subcutaneous* and *deeper-seated* set, which communicate with each other freely and repeatedly.

The superficial veins of the inferior extremities, which are situated under the skin, are united into two trunks, called Venæ Saphænæ.

The *Vena Saphæna Minor* is formed by the veins of the outer side of the foot.

This vein ascends on the outer side of the ancle; and on the back of the leg upon the gastrocnemius externus, and terminates in the popliteal vein.

The *Vena Saphæna Major*, formed by the veins on the upper part of the foot, runs along the inner ancle and inner edge of the tibia, to the inner and upper part of the thigh, where it passes through the fascia lata of the thigh, and ternates in the deep femoral vein.

The deeper-seated set of veins, or venæ comites satellites, accompany the arteries.

The tibial, fibular, and sural veins, terminate in the popliteal vein, which lies over the popliteal artery.

The femoral vein receives all the veins which correspond with the branches of the femoral artery and those of the arteria profunda.

The veins, from the inguinal glands and external organs of generation, are also joined to the deep femoral vein, which passes under the crural arch: it is then named *anterior iliac vein.*

In the more common kind of crural hernia, the tumour is situated on the pubal side of the vein: the neck of the tumour is covered by the upper insertion of the falciform process, and the epigastric artery lies on the ilial side of the hernia *.

The anterior iliac vein receives the circumflex, epigastric, and sometimes the obturator veins, and the large plexus of veins which covers the prostate gland; and from which, it is probable, a good deal of blood is derived, when that plexus is divided in the operation of lithotomy, especially when they become varicose.

A varicose state of those veins which lie over the neck of the bladder has, by projecting into the bladder, sometimes proved the cause of retention of urine, according to Mr DESAULT.

The veins of the prostate gland, according to Sir E. HOME, have sometimes been ruptured by riding on horseback.

The hypogastric vein, formed by the conjoined veins which correspond with the branches of the hypogastric artery, is united with the iliac vein. The anterior and posterior iliac veins form the common iliac; and by the union of the common iliac veins, the *Vena Cava Inferior* is formed, which, at its origin, receives the sacral and lumbar veins.

Varix is more common in the subcutaneous than in the

* Vide an account of the varieties of Crural Hernia, in my book on the Morbid Anatomy of the Gullet, Stomach, and Intestines.

deeper-seated veins, and it is generally observed to pervade all the superficial veins; but sometimes it is limited to two or three inches of the vein, which swell out to a great degree. I have seen such a partial enlargement of the vena saphæna major, near to POUPART's ligament, bear a very strong resemblance to a crural hernia.

The enlarged veins being elongated, describe a serpentine course, and sometimes they burst.

The enlargement is often succeeded by the deposition of coagulable lymph within the vein; which, according to Mr HODGSON, proves a cure, by obliterating the vessel: this coagulum is gradually absorbed; so that the enlarged vein is ultimately completely obliterated, and the blood is returned to the heart through collateral veins.

The enlargement of the veins often gives rise to an inflammation of the skin and cellular substance: this ends in ulceration, which it is extremely difficult to heal.

Another consequence of an enlargement of the veins, is the formation of a groove in the bone in the vicinity of the enlarged vein.

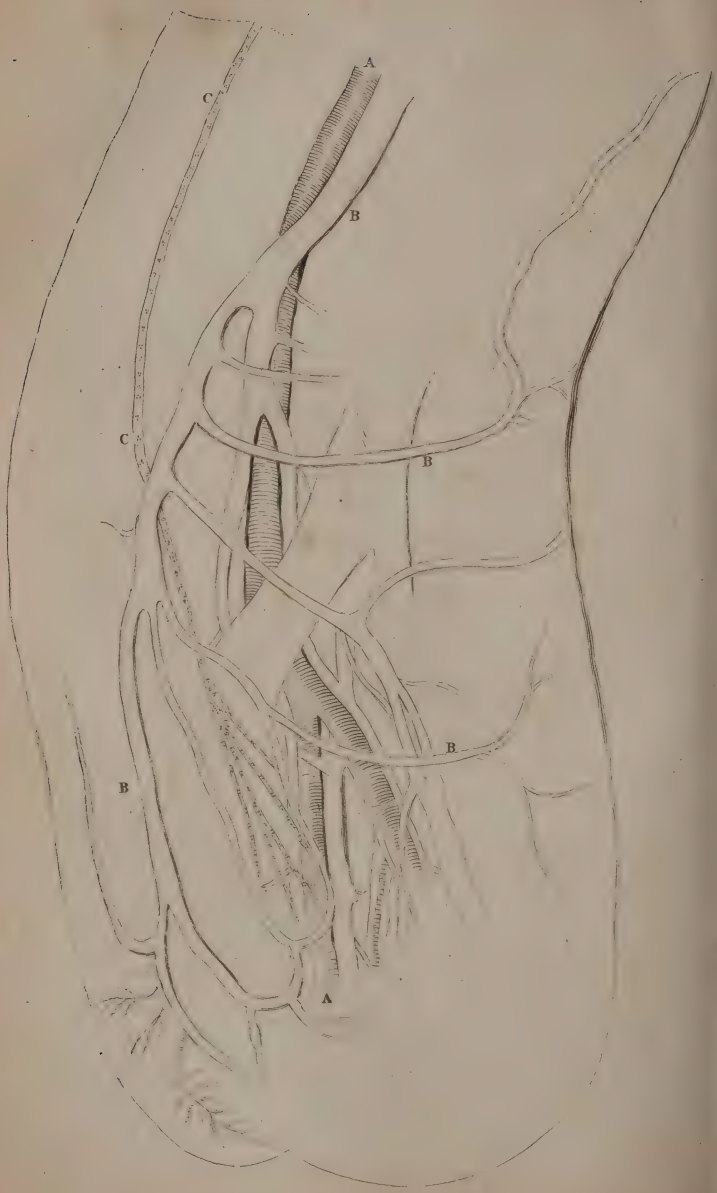
Lastly, as the enlargement of the veins is connected with the gravity of the blood, and all causes impeding the free return of that fluid to the heart, hence the beneficial effects resulting from the horizontal posture, and the laced stocking or bandaging, in arresting its progress, or in removing it.

I shall conclude this part of my work, by subjoining (Plate XI.) a representation of the distribution of the arteries and veins upon the face of a stump, after these vessels had been filled with wax, of which, as far as I know, no representotion has been hitherto given to the public.

The enlargement of the lateral anastomosing branches, when the main trunk of an artery has been obliterated in a living animal, has been proved by innumerable observations: thus, a quantity of blood sufficient for the performance of the functions of the limb flows downwards to the thigh, leg and foot, where, for instance, the iliac artery has been obstructed.

The enlargement is at first very considerable; but, in pro-

PLATE XI.



Thos Donaldson Del.

cess of time, a few only of the collateral arteries are permanently enlarged; the others collapse in different degrees, when no longer necessary to the continuance of the circulation.

Another beautiful provision for the same purpose, was discovered by Dr Parry. After a ligature had been thrown around each of the carotid arteries of a ram on the 17th of September 1815, the animal was killed on the 17th of the following October. When the bloodvessels were injected, "the old portion of the artery was found obliterated, its place being supplied by five new ramifications, uniting in different points the extremity of the inferior portion of the old artery with the superior portion."

But the very striking union between the arteries and veins on the face of a stump, has not, as far as I know, been yet explained. I have therefore inserted the engraving Plate XI., from a preparation made by my Father, which shews distinctly the above circumstances. The vessels upon which there are transverse lines, are the arteries; the corresponding veins are given in outline, and a number of dots are put upon the nerves.

In PLATE XI.

A represents the Arteries.

BBB the Veins.

C the Nerves.

PART VI.

OF THE NERVOUS SYSTEM.

CHAP. I.

GENERAL OBSERVATIONS ON THE STRUCTURE AND FUNCTIONS OF THE NERVES.

THE Nervous System is the medium by which we are connected with, and acquire a knowledge of, external objects. There is in us a principle which feels, thinks, reasons, and from which all our voluntary actions are derived.

By the nerves, impressions which are made on their sentient extremities are propagated to the brain, and sensation is produced; but in what manner this takes place, or what is the exact seat of the sensorium commune, or centre of sensation, to which all impressions communicated by the nerves are transmitted, has not hitherto been explained; nor has any light been thrown on the connection subsisting between the mind and the nervous system.

Anatomists and physiologists of all ages have devoted much attention to discover the structure and functions of the brain and nerves, and their labours have been crowned with a certain degree of success; but still much remains to be done, much is still mysterious and obscure, and many opinions which have been propagated have neither been refuted nor confirmed.

At this moment, many of the best physiologists of Europe are eager in the pursuit of discoveries relative to the nervous system; every monthly journal teems with a detail of some new experiments on that head; and much of the obscurity which hangs over this very curious and important subject may perhaps be removed by their combined exertions.

Within these few years REIL, the WENZELS, SŒMMER-

ING, C. BELL, CUVIER, SERRES, and TIEDEMANN, have thrown much light upon the structure of the nervous system of man and the inferior animals; and a new impulse has been given to investigations relative to the functions of the nervous system by the brilliant discoveries of WILSON PHILIP, BRODIE, and C. BELL, and which have paved the way to the detection of some singular facts by ROLANDO, FLOURENS, FOEDERA, and other authors.

As all animals possess the sense of feeling, and the greater number the power of locomotion, there is reason to conclude, that all are provided with nerves, though those in the hydatid, polype, and other animals, are not obvious to our senses.

In many of the lower animals we see cords, somewhat of a whitish colour, extending from the head to the tail of the animal, and connected to each other in their progress.

In the *slug*, *lobster*, and *leech*, the nervous system is exhibited in a very simple form. There is no brain; there are merely a number of cords, and ganglia connected with them, which may be traced from the head to the opposite extremity of the animal; hence the conclusion, that a brain is not essential to the functions of the nervous system, but a superadded part necessary to certain classes of animals only.

In the classes Mammalia, Birds, Fishes, and Amphibia, the nervous system is more complicated in its apparatus: a certain portion of the nervous system is lodged within the skull; the form, size, and relative situation of the protuberances and cavities of that part varies in these different classes; and there is a large cord passing down through the spine, which has been called the *Spinal Cord.*

Anatomists divide the nervous system of these animals into a larger and smaller brain, a medulla oblongata, medulla spinalis, nerves, and ganglia connected with these; and the various nerves are connected with the brain or spinal cord.

It is proposed, in the *first* place, to direct the attention of the reader to the Nerves, as these sometimes exist even in the human body, independently of the brain, and are capable of exercising their functions independently of it.

This very striking fact may be obvious by a few examples.

Thus, in monsters born without a head, the spinal cord and nerves are found to be as large as usual *.

In children (says my Father) delivered at the full time, plump and well formed in their trunk and limbs, I have observed the substance which supplied the place of the brain not more bulky than a small nut, and instead of containing a white medullary substance, it was of a red colour, resembling a clot of blood; and small cords, occupying the place of the optic nerves, were likewise of a red colour. Yet the spinal marrow, and all the nerves from it had the ordinary size and appearance.

In a monstrous kitten with two bodies, and the appearance of one head, I found the spinal marrow of one of the bodies connected with a brain and cerebellum of the common size and shape. But the spinal marrow of the other body, though equally large, had only a small button of medullary substance at its upper end, without a suitable brain or cerebellum.

Lastly, as has been above stated, many of the inferior animals are provided with nerves but destitute of brain.

From these facts, it may be inferred, that there is *an energy in the nerves, independent of that of the brain.*

The nerves of the higher orders of animals are connected with a brain or spinal cord, by a number of small threads; but in the lower animals, there is merely a sort of nervous circle near to the head, from which nerves are dispersed all over the body, or there is a double cord, which proceeds from the one extremity of the animal to the other, from which the nerves issue out in a transverse direction.

The nerves generally come off in pairs.

The nerves are cords of a cylindrical form, which divide into branches which are sent off at different angles generally at an acute angle; hence anatomists have talked of the *crow-foot division of the nerves.*

The branches of the nerves do not always diminish in thickness, in their progress to their destination. Some of the

* Vide Monro, Edin. Phil. Trans. vol. iii.

branches of the nerves follow a retrograde course. Some nerves do not subdivide, but they unite and form plexuses from which trunks of nerves take their origin. The branches of the nerves, like those of the arteries, if put together, are considerably larger than their trunks, so that they are much more extensive at their terminations.

There are cords passing from one nerve to another, and at the seat of these communications, there is an enlargement of the nervous substance, called a *Ganglion*.

There are some nerves which are suddenly expanded into a ganglion, and afterwards contracted.

The nerves at first sight appear to be similar as to colour, strength, and form; but upon a minute inspection, they are found to be essentially different in all these particulars. The texture and chemical analysis of the matter that composes the brain and nerves are similar, and I purpose to describe it under the article Brain.

The nerves of the higher orders of animals are dense whitish cords.

I have examined those of the human body two hours after death, and have remarked, that they had somewhat of a purplish grey colour, and had a shining silvery appearance.

There is a considerable difference as to the size of the nerves of different individuals, which is not connected with their stature. They vary in size at different periods of life, being considerably larger in the middle than in the decline of life, and they shrink in consequence of palsy and other diseases. The shrinking of the nerves of the eye is very obvious, when an eye has been lost; and I have observed, that the shrinking takes place in the tractus opticus of the opposite side. I shewed this circumstance five or six years ago to a German anatomist Dr Killigan, (who has devoted much attention to the structure of the nerves,) in a preparation I had at the time made, and which was taken from the body of a person who had lost the sight of one of his eyes twenty years before his death.

There is also a difference as to the size of the nerves of the different sexes; the nerves of the female are undoubtedly smaller than those of the male.

The larger nerves of infants bear a larger proportion to the other parts of the body than after puberty, but they are not on that account better adapted for the exhibition of the nerves; for the smaller branches of the nerves of the adult are larger, and less apt to give way during dissection, than those of infants.

The nerves also, like the bloodvessels, enlarge when the womb is expanded during pregnancy, as has been noticed by Sir E. Home and Tiedemann.

In a very large aneurism of the abdominal aorta, which I had occasion to examine with considerable care, the splanchnic nerves, which ran over the tumour, were very much enlarged. According to Tiedemann, the degree of sensibility of nerves bears a ratio to their bulk; an opinion which receives confirmation from two cases of prodigious aneurisms of the abdominal aorta, which before death, had caused the most excruciating agony.

Irritation applied to nerves occasions their partial enlargement. Thus, a short time after amputation, there is a tumour connected with the extremities of the nerves that have been divided, but after some time this swelling of the nerves goes off to a considerable degree.

In some instances of neuralgia, the nerves of the affected part are enlarged, which is owing to the effusion of a serous fluid into the sheath of the affected nerve.

The relief afforded by the application of cold water, of leeches and blisters, seems to afford evidence, that, in the neuralgia, there is an inflammation of the nerves of the affected part.

When a nerve has been inflamed, the fasciculi of it are enlarged, and also the bloodvessels proper to it.

There was sent to me, four years ago, the amputated arm of a soldier, who had received a wound in the fore-arm, which was followed by such excruciating pain, of several years duration, that he insisted upon his arm being removed. My assistant Mr Mackenzie filled the bloodvessels of the arm, very successfully, with a fine injection, by which the vessels of the radial and ulnar nerves were so completely filled, that these nerves assumed a uniform red appearance.

The nerves can scarcely be said to be elastic, nor do they vibrate, when irritated, in a living animal.

There are a number of bloodvessels, which are distributed upon the surface of nerves, and which also penetrate into their substance, between their component fasciculi, and which, as has been above stated, become enlarged, when in a state of inflammation.

The nerves are generally imbedded in a quantity of fat and cellular substance; they follow the same course as the bloodvessels, and are so disposed as to be well protected by the bones and their processes; and they generally follow nearly a straight course to the part on which they are distributed.

The preceding observations are applicable to the nerves of the human body.

The nerves of the inferior animals present many peculiarities. I shall describe what has fallen under my notice.

In the younger animals of the class Mammalia, the nerves, as in man, are somewhat of a redder colour than in the older.

In Birds and Amphibia, there is a greater proportion of a gelatinous substance intermixed with the more opake and whitish matter of the nerves.

In the sciatic nerve of the frog, upon the white matter, a number of brown spots may be observed, whether the nerve be stretched or relaxed.

The nerves of many of the Mollusca are, in a great measure, gelatinous, and so like the colour of the contiguous parts, that it is almost impossible to trace them, before putting the body of the animal, for some time, into spirit of wine.

The nervous system of the common leech presents a singular appearance. There is a cord of a dark colour, not unlike to a vein, half full of blood, upon which there are a number of white bodies, about the size of the point of a pin. When this cord is examined, by the aid of a common magnifying glass, it seems semitransparent in its centre, and bordered by a dark purple line. The little bodies connected with it, at the distance of about half an inch, have a lozenge shape, and present exactly the same appearance as the cord itself; and, from each of these, there are two little cords which pass in a

transverse direction, in respect to the principal nervous cord, extending from the one extremity of the animal to the other.

Decapitation proves fatal to man, but the head of a turtle or frog may be cut off, and the animal continues, for a time, to live; and even rabbits for some time survive decapitation, if care be taken to prevent the loss of blood, and to inflate their lungs.

But the union of the nerves, with a common centre, is not essential, in all animals, to sensation and life.

Some of the lower animals, as *Polypi*, may be divided into a number of parts, and each part is capable of living, and is, in truth, a perfect and sensitive animal.

Mr Dalyell has well observed, (Observations on the Planariæ,) "deadly wounds, to the majority of the creation, only serve to awaken in them the active principle of an inexhaustible reproductive power. The perpetuation of their race is effected by means the most remote from those that usually regulate the origin of animated existence;—a shapeless fragment is disjoined from the body of the parent; it remains in quiescence, more resembling the state of death; but new organs are gradually evolved, motion is resumed, and all the qualities successively displayed which belonged to the primitive whole."

The word *origin* is applied to that part of a nerve which is next to the brain or spinal cord, before it has passed into the sheath which is given by the dura mater.

As to the origin of the nerves, there is great diversity of opinion amongst anatomists, and to me it seems, that a preconceived theory has often blinded even the brightest ornaments of anatomy.

As the brain and spinal cords are fibrous, and the nerves are also fibrous, to me it seems as impossible to say, where the fibres of the brain terminate, and those of the nerve begin, as it is to determine the origin of the fibres connected with the root of a plant.

It is no doubt true, that some nerves seem to be intimately connected with certain protuberances of the brain or smaller brain, and that some nerves penetrate deeper into the

substance of the brain than others, but still we have not yet been able to detect what is the exact source of a nerve; all the length, I apprehend, we can safely go, is to affirm, that the greater number of the nerves seem to be connected with the medulla oblongata of the brain.

There is every reason to suppose, from the inspection of the diseased brain, and the symptoms which precede death from that cause, that there is a crossing of the fibres of the nerves near to their origin.

Thus, injuries inflicted upon one side of the head, generally affect the opposite side of the body, though it must be acknowledged, that there are many exceptions to this general remark, with respect to the brain, cerebellum, and spinal cord.

The crossing of the fibres of the optic nerves can be demonstrated in the human body, and in fishes.

My father has described very particularly in his book on the Nervous Sytem, the intermixture of the medullary cords of the optic nerves; and what has been above stated, *as to the shrinking of the left tractus opticus when the right eye was lost*, seemed to him to afford farther evidence of the fact.

The decussation of the fibres of the cords that compose the spinal marrow, may be shewn in the grooves, by carefully separating those cords.

The nerves have been by most authors said to take their origin from the brain; but there is as great reason to adopt the contrary opinion, and to say *that the brain takes its origin from the nerves.*

That the nerves do not take their origin from the brain seems to me obvious, as the whole of the white matter of the brain, cerebellum and spinal cord, is not expended in forming nerves, the white matter of the brain being of much greater bulk than all the nerves conjoined.

As the brain is proportionally smaller in quadrupeds and fishes than in man, the nerves in the former are larger, or are proportioned to the extent and bulk of parts over which they are distributed. Besides, the feeling is as acute, and the muscular energy as great, as in animals provided with a larger brain.

The brain of the ox does not weigh above one-fourth of the human brain; yet the nerves connected with it are six times larger; or they are twenty-four times larger than they should have been, supposing that in both the whole white part of the brain were sent out from the head in the form of nerves.

Hence the whole brain is not intended to form nerves; and after making such a conclusion in respect to the human brain, it seems probable, that, in the inferior animals, a part of the brain is destined for different purposes than those performed by nerves; an opinion which gains weight, from the circumstance that the destruction of a part of the brain is not followed by a loss of feeling, or of the power of motion.

The nerves have three coats, the Dura Mater, the Arachnoid Coat, and the Pia Mater; and besides these, each nerve has a membrane which is proper to its component filaments, called *the neurilma:* this may be readily shewn, by immersing a nerve in an alkaline solution, by which the medullary mater is removed: thus the nerve looks like a bundle of hollow tubes. The internal surface of the neurilma is smooth and polished, like the innermost coat of an artery or vein; it sends out several small processes, which are connected with the white matter of the nerve.

The nerves, when minutely examined, are found to be composed of fibres, and each fibre is composed of a number of minute fibrils of the same nature as those of the brain and spinal cord; but they are much more distinct, and are enveloped in their proper membrane. Leeuwenhoek observed, by the aid of his microscope, that the most minute fibre resembles a larger bundle, and he was not satisfied that he was looking upon one single fibre, but probably had in view a bundle of small fibres.

Reill, who devoted much attention to the minute structure of the nerves, describes them as composed of very fine filaments of different thickness, some like those of a hair, and others like those of silk, which are inclosed in a very fine web, which he has called *neurilma.*

I have examined with some care transverse sections of nerve, and especially those of the optic nerves of the horse and goose,

in which, by the naked eye, the fasciculi that compose them are obvious: in the goose the fasciculi are larger than in the horse.

A number of small bloodvessels are proper to the coats of the nerves. In the nerves, there is a white as well as a grey coloured substance, derived from the pia mater.

The proper nervous substance is more abundant in some nerves than in others, especially in the optic and auditory nerves. When the matter of the nerve is examined, it looks semipellucid, and with a white and opake looking fibre passing through it in transverse and serpentine lines: these are most distinct, when the nerve is in a state of relaxation, and they disappear to a certain degree, when a nerve is put upon the stretch, which led my Father to suppose them intended to accommodate the nerves to the different states of flexure and extension.

The nerves are supplied with arteries from the neighbouring bloodvessels, and they have also corresponding veins; and where inflammation has attacked the nerve, it assumes a red colour, from the number of bloodvessels dispersed on it.

The nerves do not readily putrefy after death, nor are they affected during life by gangrene. When the nervous matter is subjected to chemical analysis, it is found to be similar to that of the brain.

Of the Structure of the Nerves.

All parts of the body probably are supplied with nerves, but not to the same extent. The organs of the senses, of generation, and of voluntary motion, are largely supplied with nerves.

The different degrees of perception have been stated to bear a proportion to the number of nerves proper to a part;—a position which cannot be admitted, as the nerves of the heart, a very sensible organ, are very small.

Few nerves can be traced into the glands; yet these are very sensible organs, and the nature of the fluid secreted by them is much affected by passions of the mind, and other causes which affect the nervous system.

Few nerves can be traced into the serous membranes, yet these membranes when inflamed are highly sensible. The bones also receive few nerves; yet these, when diseased, give exquisite pain.

Nerves may be traced into bone, and also into the teeth *.

We have not yet been able to trace nerves into the cornea, the cuticle, the enamel of the teeth, nor into the membranes that envelope the fœtus.

The organs of sense receive their nerves from the brain, but the muscles, generally speaking, receive their nerves from the spinal cord. The nerves of the thorax, abdomen, and pelvis, are derived from the ganglia of the sympathetic nerves, and par vagum of the eighth pair.

When we examine, even with the utmost attention, the terminations of the nerves of the ear, nose, or eye, we discover no appearance of a neurilma.

The optic nerve terminates in an expansion which has been described as greyish; but, in a very recent eye, I have remarked that it is nearly transparent; it becomes greyish by keeping or immersion in spirits.

After removing the cornea, iris and crystalline lens, upon looking through the eye, we see, on the temporal side of the optic nerve, a dark spot surrounded by a lemon-yellow † colour, which gradually becomes fainter from the central spot; but in the eye of a criminal, which I lately examined about six hours after he had been hanged, I could not observe any fold in the transparent retina, which Sœmmering, the discoverer of this dark spot of the retina, has described so particularly. The colour of this substance on the retina is by no means uniform: in different individuals, it varies between a yellow and an orange green.

The portio mollis of the seventh pair of nerves terminates in a pulpy mass, which my Father discovered to form a very intimate plexus. The nerves distributed upon the skin and tongue terminate in the papillæ proper to these organs.

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* Monro's Nervous System. † Syme's Nomenclature of Colours.

My Father remarks, that the nerves in the ear of fishes, which terminate on the semicircular canals, and in the sac which contains a cretaceous substance, suddenly become pellucid, which is owing chiefly to the white medullary substance dividing into its constituent threads, or becoming thinner.

It is in many instances very difficult to trace the very minute branches of the nerves, they are so much interwoven with the structure of the part in which they terminate; and, in tracing the minute progress of the nerves, the anatomist is struck with the difficulty of distinguishing the nervous fibrils from the smaller branches of the arteries or veins, or from the threads of the cellular substance. I have seen, especially in the human penis, those membranous webs, in which the nerves terminate, and which consist of a minute plexus of nerves.

Mr Swan has described other nerves, as having membranes of the same description connected with them; and he adds, "that, in the horse's face, he found the trunks of the nerves having a very flat appearance, and the continuations of them having a round and thicker form; and, in several places, he satisfactorily observed that membranous and plexiform appearance with the naked eye, which nearly resembles the magnified termination of the minute nerves in the human body."

The nerves are conjoined in three different ways.

1*st*, The nerves are joined together at acute angles, and form *plexuses*. The greater number of nerves are composed of fasciculi, disposed in a longitudinal direction, in respect to each other; but the fasciculi of the par vagum of the eighth pair, and sympathetic nerve, are more regularly connected with each other; and their fibres cross each other, as in the ganglia of the nerves.

2*d*, Nerves running in opposite directions, are connected by their small branches or *apices of these branches forming networks*, which, at first sight, seem to resemble the anastomoses of the bloodvessels.

3*d*, In certain parts of the body, several nerves enter into a knot, called *ganglion*, and from the opposite side of the knot nerves are sent out.

The nerves, in their course, are united by plexuses, in which the fibres of the different nerves are intermixed, and every nerve under the plexus consists of all the nerves which entered the plexus.

Some of the nerves which run in opposite directions are connected by small branches; as the second branch of the fifth pair of nerves, with the portio dura of the auditory nerves. In the ox, my Father remarked, that the small branches which come off beyond the union of the two larger nerves, consist of the fibres of both.

In the whole nervous system, the particular cords, of which the particular nerves consist, form, according to my Father *, *within their proper sheaths, a succession of plexuses, in which their fibres are intermixed and combined again.* Thus the danger of diseases and injuries of the trunks of the nerves is materially diminished.

Of Ganglia of Nerves.

A particular nerve is expanded at a certain place or places, which expansion has been called a Ganglion.

There are communications between a number of nerves; and where these communications take place, there is an enlargement or ganglion.

These ganglia have been very particularly described by my Father, and after him by Scarpa, and their descriptions agree in almost every particular.

Weber and Lobstein, still more lately have described ganglia of the sympathetic nerve very particularly. There are some single nerves, which are enlarged, so as to form a ganglion, and the nerve is afterwards contracted.

The ganglia are covered by a fibrous membrane.

The ganglia are little flattened bodies, connected with the nerves, consisting chiefly of medullary matter; and these ganglia are different in size and shape in different nerves, and even in the same nerve, as in the sympathetic.

All ganglia seem to be similar in their structure.

* Vide Nervous System, p. 44.

There is a substance somewhat of a yellowish colour, and bearing some resemblance to very fine fat, or very fine marrow, which is also found between the fibres of the nerves composing the ganglion.

In very fat subjects this substance is more abundant than in the lean, and it is not limited to the human body: one of the best means for exhibiting it is to make a section of the GASSERIAN *ganglion* of the horse.

There are a number of bloodvessels proper to the ganglia, which are derived from the neighbouring arteries, and which penetrate the pulpy substance and fibres that compose the ganglion.

Many nervous cords may be traced on the surface of the ganglion, from their first attachment to the ganglion, till they have parted from it, without any substance intervening of a different texture from that of the nervous cords elsewhere.

The nerves, in their course upon the surface of the ganglion, divide into smaller nerves, and are again collected into larger cords, in such a manner that every nerve that comes out from the ganglion, consists of fibres from two or more of the nerves which enter the ganglion.

The nerves within the ganglia retain their jointed appearance.

The cords which come out from the under end of a ganglion are generally larger than those which enter the upper end; but there are exceptions to this rule in the course of the sympathetic nerve.

Every nerve connected with a ganglion appears to contain cords, running in opposite directions; ascending, for instance, and descending; or where nerves are connected to the upper, under, or outer part, or side of a ganglion, (which is the case of the thoracic ganglia of the sympathetic nerve), the nerve at the side appears to consist of cords, which divide into ascending and descending cords, that are combined with the cords which compose the upper and under nerves *.

My Father, after having described, with great minuteness,

* Vid. Nervous System, p. 54. and Plate XX. fig. 1. B.

the structure of the ganglia, has observed: "Upon the whole, all the nerves which issue from ganglia seem to be formed by a combination of threads, from many sources; and, besides this, the nerves, in their passage through a ganglion, seem to receive new energy from the vascular matter of the ganglion."

My Father has thus described the ganglia: "*First*, Several branches of the nerves, which enter a ganglion, run upon its surface, separating from each other, and joining again, so as to form new combinations of threads at the other end of the ganglion. *Secondly*, When we cut a ganglion, we are so far from finding that the course of the nerves is interrupted within it, or that it is a substance, totally different in its nature from the nerves that enter it, that we are able to trace, in every part of the ganglion, nerves distinguishable by such folds or joints, as are seen in them in all other places. *Thirdly*, In the substance of the ganglion, we see nervous cords leading from any one nerve, connected to the ganglion, to the greater number of, if not to all, the other nerves connected with it; from which we may conclude, that various other combinations of the nervous threads take place within it. *Fourthly*, It appears very difficult, in many instances, to distinguish all the nerves which enter a ganglion, from those which are sent off from it; and, of course, it is difficult, or impossible, to determine all the sources from which any branch sent off from the ganglion, is derived. For example, although the nerves, at the upper end of a thoracic ganglion, of the great sympathetic nerve, are composed chiefly of descending branches; and, in like manner, the two nerves which tie it to the proper dorsal nerve, are chiefly derived from the dorsal, yet there seem to be ascending branches from the nerves below, and others sent outwards, from the ganglion, to the proper dorsal nerve; and probably the splanchnic nerves receive threads from all these sources. *Fifthly*, The nerves which issue from ganglia seem, as authors have acknowledged, *to be more bulky than the nerves we may suppose to enter ganglia*; yet I have not been able to discover, that the coats of the nerves going out were thicker, or diffe-

rent from the coats of the nerves going into the ganglia; hence there is just reason to suppose, *that nervous matter is furnished by the ganglia. Sixthly*, To strengthen the supposition, that the ganglia are to be considered as sources of nervous matter and energy, I would observe, that the yellowish, or brownish matter of ganglia, has numerous vessels conveying red blood, as in the cortical substance of the brain, dispersed upon it. That its colour, especially in man, very much resembles the cortical substance of the brain. That in several children, in whom the brain had either been originally imperfect, or compressed by accident, its colour and consistence still more closely resembled that of a ganglion, as to the greater hardness of the ganglia, than that of the cortical substance, which, to Dr Meckel, has appeared to afford sufficient reason for denying that they serve for secretion; that, I apprehend, will evidently appear necessary, to defend them from external violence, or the pressure of the muscles, and other organs. To which I would add an observation on the first pair, or olfactory nerves, which seems to carry with it considerable weight, to-wit, that, in man, the trunk of the olfactory nerve has adhering to its end, a cineritious bulb, situated within the cranium, and which is evidently of the same texture with the cortical matter of the brain. Now, in fishes, I have found, that the olfactory nerve has no such bulb within the cranium, but when we trace that nerve forward, towards the nose, which is in them at a great distance from the cranium, we find a ganglion, near the nose, which supplies the place of this bulb, and from which more nerves come out than enter in."

Having premised these general observations, relative to the disposition and structure of the nerves, it seems necessary to subjoin a few remarks on their functions.

The nerves are the organs that intervene between the living principle and the rest of the body, through which various impressions are propagated.

The feeling is not resident in the nerve *; it is merely a con-

* A physiologist of eminence has, by dividing the phrenic nerve of horses, endeavoured to prove, that the nerves retract after having been divided, and that

ductor, like the staff of a blind man, by which he gains a knowledge of the presence of external bodies.

In the more perfect animals, the feeling principle occupies but a small space of the brain, and probably near to the origin of the nerves.

If the nerve of a limb be divided, so that the communication through it is intercepted, the feeling is lost: it may be pricked without causing pain.

It is singular, that, after a limb has been amputated, if the nerves of the stump be irritated, pain is not felt in the part irritated, but is referred to the extremities of the toes: the injury runs backwards to the feeling principle, and that refers it to the termination of the nerve: hence, when we wish to determine the feeling which the wound of any part gives, we must preserve uninterrupted the communication with the brain.

What has been stated as to the nerves applies also to the spinal cord, if it be divided transversely; all the parts beneath it become paralytic, but the upper parts of the body, which communicate with the brain, preserve both sensation and motion.

In short, the sensibility of a part depends upon its connection with the brain.

The sensibility of certain nerves is very much modified by a variety of circumstances. Thus, the continued action of light and heat, to which many mechanics are exposed, the straining of the eyes in watch-making, engraving, reading with candle light, and other occupations, have a great effect in weakening the sight.

The sense of hearing becomes obtuse by continued noise, as by the noise of cannon.

The sensations communicated by the nerves are very various, owing probably to their peculiar structure, and to certain properties inherent in them; thus the optic nerve conveys the

there is a contraction of the nervous fibres, which is independent of the brain with which they are connected, or with the muscles on which they terminate.

But I doubt whether a nerve possesses such properties as have been ascribed to it; I have not observed any degree of retraction of the eighth pair of nerves, after it has been divided.

impressions of light, the acoustic nerve those of sounds, the olfactory nerve those of different odours.

It is well known, that certain painful sensations are often connected with peculiar nerves; as with the superciliary infra-orbitar, portio dura of the seventh pair, the sciatic nerve, and occasionally with the nerves of the arm and under-limbs. I have also seen such sensations connected with the par vagum; in one such instance they were accompanied by stricture of the gullet; and I observed an evident enlargement of the par vagum, in its course along the gullet. It has been already noted, that painful affections of the nerves of the fingers and arm are sometimes excited, by external injury, and also by tumour connected with the substance of the nerves.

The manner in which the paroxysm begins is a striking example of disordered sensation. It comes on with an aching in the nose, or slight tingling in the finger or toe, which runs up along the arm or leg, towards the head; and there are some persons who describe these sensations as being like to an electrical shock. In some, the progress of the pain is gradual, in others very rapid.

The division of the nerve has been said to remove the agony of the patient, but this does not always afford relief, which may be owing to the communication between the seat of the disease and the brain not having been completely intercepted. The relief given is more generally only of a temporary nature, owing to a reunion of the divided portion of the nerve. That a divided nerve is reunited by a real nervous substance, is evident from the functions of that nerve being, after a time, restored, as has been proved by the experiments of my Father, Dr Haighton, Mr Cruickshank, and others, and also by the failure often attending the operation of dividing the nerve, from which very painful sensations arise. Meyer has supplied us with a direct test.

The medullary substance is not acted upon by the nitric acid, which destroys the neurilma; thus we can distinguish whether the medium of union between the divided nerves be real nervous substance or not.

The relief is more certain when a piece of the nerve has

been cut out, and the divided extremities of the nerves turned away from each other; but this also does not invariably succeed, even though an inch of the nerve be removed. I have lately had an opportunity of examining the metacarpal nerves of a horse, after portions had been cut out to remove lameness, and found a restoration of an inch of the nerve, the place of the whole nerve having been supplied.

From what I have observed, it seems to me, that when such disordered sensations occur, there is an increased local action of the bloodvessels distributed on the nerve or nerves. I have often, in cases of tic douloureux, remarked the violent pulsation of the angular, labial, and nasal arteries, and have observed the pain removed by the affusion of cold water, the applicacation of leeches, of a blister, or by an attack of erysipelas of the face.

The above opinion also seems probable, from the circumstance, that, after the recovery of the sensibility, which there is reason to conclude proceeds from a reunion of the divided nerve, there is sometimes a morbid sensibility left in the part supplied by the nerve that has been divided,—an opinion of which the following case affords an illustration:

A gentleman, by a pen-knife, accidentally divided the little finger transversely, and down to the bone. At the time of the injury, the point of the finger was rendered almost insensible; but, after some time, it acquired a morbid sensibility, so that he could not suffer it to be touched even slightly; and, what is striking, this morbid sensibility of the finger has continued for years. From what has been stated as to the mode in which more painful sensations are propagated in the disease called *Tic Douloureux*, the reader may be disposed to think that these sensations are propagated not only along the nerve more immediately affected, but also along the nerves with which it communicates; yet there have been instances published, which are adverse to such an opinion.

It yet remains to be determined, whether the nerves communicate their influence to other nerves, the communications of which with the brain have been cut off. The case related by Mr Earle shews, that the sensation is not communicated

by anastomoses. That gentleman cut out a portion of the ulnar nerve behind the inner condyle of the os humeri, and five years after the operation, sensation in the little finger was very imperfect. Now, might not the communication of the ulnar nerve beyond the part that had been cut out with the median and spinal nerves, have kept up the communication with the brain?

The case mentioned by Mr SWAN, of a person who divided the median nerve, is equally in point: the part on which that nerve is distributed always remained cold.

In opposition to the above cases, it merits mention, that there are certain sympathies and certain sensations which seem to depend upon certain communications of the nerves; thus vomiting is excited by thrusting the finger into the mouth, as the eighth pair of nerves supply both the pharynx and stomach. Strong odours induce a flow of tears, as the different branches of the fifth pair supply the nose and the lacrymal gland; and, owing to the numerous communications between the great sympathetic and eighth pair of nerves, many very peculiar sympathies are excited. It must also be admitted, that there are many instances of a remarkable degree of sympathy, when there is no evident union between the nerves of the sympathising parts.

There are many differences as to sensation in different animals, which are referable to the degree of perfection of the organs; and, in certain species, certain organs are more perfect than in others. Sensations are also communicated by peculiar states of the internal parts to which the nerves are distributed, without any external excitement, as in dreaming; hence a sensation is not a communication by an external concussion, but by a peculiar condition of the brain.

There are many peculiarities as to sensations,—as to the exhaustion consequent to mental exertion,—as to the continuance of peculiar sensations,—as to the susceptibility of the nerves for receiving these,—as to the operation of medicines, and of inflammation in weakening or increasing that susceptibility, which it is not my province to describe.

Lastly, It may be observed, that it has not yet been deter-

mined by experiment, whether or not there exist any intrinsic differences as to the sensibility of the nerves of particular animals.

Upon the nerves the power of motion depends.

A muscle is a machine *sui generis*, the nature of which is yet by no means understood. We are ignorant of the real texture of the muscle, and we have not yet been able to contrive a machine that shall, in any tolerable way, represent its action.

Whether does a muscle possess a power of motion inherent in it, or what HALLER has called a *Vis insita*, or is it a machine acted upon by the mind determining into it the energy of the brain?

HALLER, from having noticed that the heart, or other muscle of an animal, when detached from the body, continues to contract for a considerable time, was led to adopt the opinion of a *vis insita* being inherent in muscles, as, from the communication with the brain being intercepted when the heart is removed from the body, it cannot be said that the mind is throwing the influence into the muscle.

Though I do not pretend to explain the cause of action of a muscle detached from the body, yet we understand it as well as we do the rousing of the *vis insita;* they are both unintelligible.

There are two powers inherent in muscles,—a contractile powér, which they possess independently of the brain, and also a power of contraction which they derive from the brain.

Every circumstance which destroys the one influence, the nervous, destroys equally well the *vis insita* of HALLER; and again, those substances which, when applied to the muscles, the most readily rouse those into action; when applied to the nerves and brain of the animal, do so likewise: thus, upon applying laudanum to the heart, as soon as the inner and sensible part of the heart is touched with it, all farther motion of it ceases, and the *vis insita* is quite destroyed. If, previous to such an experiment as the above, the aorta of the animal be cut through, so as to interrupt the circulation, the distant muscles are deprived of their power, through the intervention of the

brain; hence there is the same influence in the fibres of the heart, determined from the brain to the muscles. If the muscles be touched by an irritating substance, as a saline body, or the nerve which runs to the muscle be touched with the same, the same effects are produced, whether we touch the muscle immediately, or the nerve, or the brain from which it receives its influence.

It may be also observed, that when, in consequence of an injury done to the brain, the patient is deprived of sensation and voluntary motion, those actions which are performed by organs which are not under the dominion of the will, as the stomach and heart, still go on for a considerable length of time; but, if the nerves proper to these involuntary organs be divided or compressed, these actions cease in a very short time.

Dr Wilson Philip (Chap. III.) *, has endeavoured to prove, that the power of the muscular fibre is independent of the nervous influence, and that the muscles of voluntary motion bear the same relation to the nervous system, which the heart and bloodvessels do, namely, that their power is independent of this system, although they are influenced through it; the only difference being, that they are always excited by the nervous influence, while the heart and bloodvessels are only occasionally so.

In a former part of this work †, I endeavoured to explain how far the functions of the arteries are under the influence of the nerves. But it remains to be considered whether we are to adopt the opinion of Berzelius, that the secretions of animals depend upon the nerves.

From the anatomy of the monster described by my Father, it is proved that secretions do not depend upon the brain; for, in that instance, there was no head; and, in the case mentioned by Mr Laurence ‡, the child lived for four days, where there was neither brain nor cerebellum; and the secretions from the stomach, intestines, and kidneys were quite natural.

The circumstance of the bronchi of an animal, whose eighth pair of nerves has been divided, being always filled by a frothy

* On the Vital Functions. † Vol. ii. p. 57.

‡ Med. Trans. Chir. of London, vol. v.

mucus, which prevents the lungs from collapsing after death, is sufficient evidence of the continuance, and I should say increase, of the healthy secretion from the bronchi.

I kept a dog for several months after the eighth pair of nerves had been divided; and it appeared to me, that the quantity of fæces discharged by the anus was much greater than is natural. The animal was much emaciated, from the constant derangement of the functions of the stomach.

The division of the eighth pair of nerves, seems to derange the functions of the stomach to a great degree, perhaps by suspending the secretion of the gastric juice; but it does not tend to lessen the fluid secreted into the windpipe and its branches, or into the intestines.

It has long been an opinion, that all the nervous threads do not perform the same function, and which was probably suggested by the circumstance of the sensation of a limb being lost, but not the power of moving it.

Haller and Sauvages adopted the above opinion; and it has been within these few years advanced by Dr Wilson Philip, and Mr C. Bell. According to the former of these gentlemen, the bundles of nervous fibres connected with the brain and spinal cord, consist of two sets of fibres, which are subservient to different purposes.

Mr C. Bell proved this rembarkable fact by experiments on the nerves connected with the anterior and posterior fasciculi of the spinal cord, the posterior set of which he found to be subservient to sensation, the anterior to motion; and these observations have been confirmed by the subsequent experiments of Mr Majendie.

Much difference of opinion has, in all ages, prevailed, and still prevails, as to the mode in which impressions are conveyed along the nerves.

The comparison made between the vibratory action of a nerve, and that of a vibrating wire, cannot be admitted. The one is a soft, the other a hard substance; besides, vibrating cords or wires of different lengths communicate different sensations; whereas the nerves branch out in all directions, and similar sensations are communicated by these cords of diffe-

rent lengths, and pressure intercepts the progress of the nervous influence.

On account of the velocity with which impressions are conveyed, the nervous influence has been supposed to resemble the electrical fluid.

Aldini supposed, that an etherial fluid is generated in the animal economy; and according to Valli, those substances that convey electricity, are also conductors of the nervous fluid.

My Father was led, by a number of experiments, (of which I gave an account in my Outlines of Anatomy), to deny the identity between electricity and the nervous energy.

"From these experiments, it is proved, that, whilst the electrical fluid is passing from the toes, upwards along the muscles, it does not throw them into convulsions, but that it does so, as soon as it begins to pass along the trunk alone, of the nerve. At that instant, therefore, *the electrical fluid is moving in the direction upwards, and the nervous energy is moving downwards, from the trunk of the nerve into the muscle*, or in the trunk of the nerve, the electrical, and the nervous energy are moving and acting in contrary directions. Hence we are led to infer, that THE NERVOUS ENERGY IS DIFFERENT FROM THE ELECTRICAL, AND THAT THE NERVE IS MERELY STIMULATED BY THE ELECTRICAL FLUID."

Dr Wilson Philip is a strenuous *advocate of the identity of the nervous and galvanic fluids;* and his very remarkable discovery of the galvanic influence being a substitute for the nervous influence, is strong evidence of the accuracy of his opinion.

The observations and experiments detailed in his ninth chapter, afford reason to believe, that the nervous and muscular powers depend on chemical changes, and that the agent which produces the phenomena is *galvanism.*

After dividing the eighth pair of nerves, and thereby destroying the functions of the stomach, Dr Wilson Philip found, *that, by the agency of galvanism, the digestive powers were restored.* He has also proved, that *indigestion may be removed by galvanism*, when inflammation is not present, and

he has published a case supplied to him by Mr Earle, in which indigestion, occasioned by a disease of the spinal cord, was removed by galvanism; and, in the Philosophical Transactions for 1822, the same author has published two positions, relative to the influence of the voltaic battery, in obviating the effects of the division of the eighth pair of nerves: "1*st*, That the nervous energy or power is not entirely interrupted or cut off, when a nerve is divided, provided the divided ends be not forcibly and extensively separated from each other; 2*d*, That electricity is capable, under certain circumstances, of causing the extremity of the divided nerve to maintain the most essential of those functions which it enjoyed in an undivided state *."

The *nerves have been supposed*, by Galen and Haller, *to be hollow tubes*, through which a subtile fluid passes from the brain to the muscles for the purpose of voluntary motion, and from the sentient extremities to the brain for sensation; but this opinion rests upon an unstable foundation, for there is no evidence whatever of the nerves being hollow. The solidity of the nerves is admitted by all modern anatomists.

The nerves have been supposed to be the source from which the body is nourished: 1*st*, Because it has been stated, that the brain exists before the heart; 2*d*, Because emaciation is the concomitant of palsy, owing, it is supposed, to a want of nourishment conveyed through the nerves.

Haller, who has traced the evolution of the fœtus, makes mention of the size of the brain of the chick in ovo, soon after incubation has been begun. *After thirty hours the brain is seen;* and, on the eighth day of incubation, the brain does not appear opaque, white in its medullary part, and cortical without, but it is clear like water: as soon as the head is seen the chest appears; therefore, the heart is visible as soon as the brain. At the end of the second day, the heart appears large, and not sooner, because it was transparent.

* Upon this head, the reader would do well to read the observations of my colleague Dr Alison, in the Quarterly Journal of Science, vol. ix. p. 120.

The brain cannot grow without the heart, the blood being the source from which it is formed; besides, the grey part of the brain abounds with bloodvessels, which cannot be supposed to exist without the heart, nor to grow by any power *ab extra*.

The heart, therefore, exists from the beginning, and the evolution of all the other parts of the body depends upon its power, and of the brain, in common with the rest of the body.

The inferior animals possess sense and power of motion, in a greater degree than men; but our brain is of a more complex structure, and our faculties are more extended.

That a paralytic limb shrinks must be admitted, but not to the same degree as a part deprived of its nourishment; in proof of which, when my Father had divided the nerves of the limbs of several animals, thus depriving these of sense and motion, after the lapse of fifteen months there was but little difference between the sound and the paralytic limb.

The confinement to which the animals were subjected, and the want of activity of every muscle, and of every vessel, afford a ready explanation of the slight degree of shrinking of the limbs the nerves of which had been divided.

The dividing the nerves proper to the glands, has an obvious effect in diminishing the quantity of the fluids secreted by these. This fact was rendered evident by Nuck. Thus the quantity of saliva formed by the parotid gland was much diminished; because the bloodvessels had been deprived of the invigorating principle usually communicated to them by the nerves.

Before admitting the brain to be the source of nourishment, it must be proved, 1*st*, That an animal cannot be formed without a nervous system; 2*d*, That the growth of different animals is proportioned to the size of their brain, and to the nerves proper to them; 3*d*, That the nerves are hollow; 4*th*, That the more sensible parts grow more rapidly than the less sensible.

Dr Clarke's testimony completely exposes the futility of the first of the above positions. He has described (in the Phil. Trans.) a monster, in which skin, muscle, tendon and

ligament, bone and cartilage, were found, but *no part of the nervous system.* My Father has stated, "I have found the limbs very plump, though the brain was small. Nay, in some monsters, the head has been wanting, yet the limbs were as large and perfect as common *." If the growth of the body were proportioned to the size of the brain, a man should be larger than an elephant.

What has been above stated, is sufficient evidence of the nerves being solid cords.

That the nerves are not a source of nourishment, was long ago proved by the experiments of my Father.

He divided the spinal cord and sciatic nerves of frogs; but notwithstanding this great violence done to the nervous system, the limbs of the animals still continued to grow, and even when he broke the limbs of some of the subjects of his experiments, *the bones were reunited by callus*, and the wound of the flesh healed; hence we conclude, *that the nerves are capable of exercising their energy, independently of the brain.* Lastly, the sensible parts do not grow more rapidly than the insensible.

CHAP. II.

ON THE BRAIN AND ITS INVESTING MEMBRANES.

THE Brain is the common centre of the Nervous System, to which the impressions of external bodies on the nerves are communicated, and from which those actions originate which are performed by the organs immediately under the dominion of the will.

The brain is the seat of the intelligent, thinking, and rea-

* Nervous System, p. 83.

soning principle; in proof of which, though the spinal cord and nerves be divided or diseased, the mental powers continue unimpared. This is obvious in diseases of the spinal cord: those parts of the body which receive nerves below the seat of the disease become paralytic; but there is a loss of sensation and voluntary motion when the brain has been compressed.

The brain is that mass of matter which, in man, fills the skull; and which corresponds in form with its inner surface.

The brain is well protected from external injury by the skull, and softer parts which cover it.

The several bones of the skull are so disposed as to form a solid case, which admits of the growth of the brain, and prevents the effects of the pressure of the atmospherical air.

The brain is covered on its upper part by the frontal, parietal and occipital bones; its fore-part rests on the orbitar processes of the frontal bone, and its posterior part upon the process of the dura mater, called Tentorium cerebello-superextensum.

Owing to the peculiar form of the skull, and the diploe between its component tables, the brain is not liable to suffer from external violence: thus, the effect of a blow is, to a certain degree, averted, a shock being less readily communicated through the spongy diploe, than through more solid bone.

The brain is somewhat of an oval form: it is broader behind than before; the sides are slightly compressed, and at the under part there are many projections and fissures, which correspond with the inequalities at the base of the skull.

To the touch the brain is somewhat elastic.

The brain varies a little in colour in different individuals, and in different animals, and at different ages. I have examined it in a criminal about three hours after death, and found it to be of a greyish-brown tint in the adult. The colour, however, depends on the quantity of blood which is sent to it: hence it is redder in early than in advanced life, and becomes still more so in consequence of inflammation. In old age it becomes of a greyish colour, and also in persons who have died from dropsy or chronic disorders.

The colour of the substance of the brain is destroyed by maceration in water, in acids, or alcohol.

The weight of the brain of a full grown man weighs about three pounds avoirdupois; that of a woman is somewhat less.

Messrs WENZEL have paid great attention to this department of anatomy, and have published a very interesting Table, of which the subjoined is an extract.

AGE.	Weight of whole Brain.	Weight of Brain only.	Weight of Cerebellum.	Proportion of Brain to Cerebellum.
	Grains.	Grains.	Grains.	
Male embryo of 5 months,	720	683	37	$18\frac{17}{37}$: 1
Female embryo of 8 months,	4960	4610	350	$13\frac{6}{35}$: 1
Girl at birth, - -	6150	5700	450	$12\frac{2}{3}$: 1
Girl 3 years old, - -	15240	13380	1860	$7\frac{6}{11}$: 1
Boy 3 years, - -	13050	11490	1560	$7\frac{57}{156}$: 1
Man 18 years, - -	20940	18474	2466	$7\frac{202}{411}$: 1
Man 31 years, - -	24120	21480	2700	$8\frac{1}{21}$: 1
Man 54 years, - -	20580	18060	2320	$7\frac{55}{81}$: 1
Man 63 years, - -	22500	19780	2720	$7\frac{37}{116}$: 1
Man 72 years, - -	22620	20200	2420	$8\frac{42}{121}$: 1
Man 80 years, - -	19080	16500	2580	$6\frac{51}{129}$: 1

ARISTOTLE and PLINY have described the human brain as larger than that of any animal. This holds true, excepting with respect to the elephant and larger cetacea. But when we compare the bulk of the brain in respect to the body, many exceptions to the above observation present themselves.

According to BUFFON, that of the seal bears a greater proportion to the rest of the body; and, according to CUVIER, the same holds true in respect to the mole and to many birds: further, the brain of the elephant, and of horned animals remarkable for their sagacity, is, in proportion to the bulk of their bodies, below the average standard.

I subscribe entirely to the sentiments of Mr LAWRENCE on this point. He says,

"It must be acknowledged, that the inquiries into the relative weight of the brain and the body, and the comparison between the former and the nerves connected with it, have

not yet afforded any precise and clear information respecting the differences between man and animals, nor on the grounds of the infinitely various faculties that distinguish different animals. It can hardly be expected that these matters will receive any clear elucidation while we continue so ignorant, as at present, of the functions executed by the different parts of the encephalon.

"The basis of the position so much insisted on by SŒMMERING is an assumption, that a certain bulk of nerve requires always the same proportion of brain for the execution of its office,—a datum by no means self-evident. The comparison of the nerves to the brain in general is not satisfactory; we should wish to know the relative proportions of the cerebrum, cerebellum, and medulla oblongata.

"The assertion, that it (the human brain) has the largest cerebrum in proportion to the cerebellum, does not appear to be quite correct. It has, however, the largest cerebrum in proportion to the medulla oblongata and spinalis, with the single, and indeed singular, exception of the dolphin *."

Besides weight and size, according to SŒMMERING, there are fifteen anatomical differences between the human brain and that of the common tailed apes.

As life advances, the brain acquires a much greater degree of firmness, and it may be observed, that good living produces a most manifest effect on the brain: thus the brain is much firmer in those that are well fed, than in those who live on poor diet; and, according to MORGAGNI, and BONNET, the character indicates the degree of firmness of the brain; for the two former distinguished anatomists have stated, that the brains of the proud and irascible are hard, dry, and coriaceous, whereas those of the meek are soft.

The above remark ought to be received with caution, and is liable to many exceptions.

I have examined, with considerable attention, the state of the brain in several criminals, and, in four or five instances, about two hours after death, and have invariably found the

* Lectures on Comparative Anatomy.

brain soft externally as well as internally, and of a paler colour than usual; and there was nothing particular as to the grey or white matter of the bone. In two instances there was a small quantity of a reddish fluid within the ventricles of the brain; and, upon examining the brain, in one instance, there was about half an ounce of a colourless fluid at the base of the brain. In three persons there was a slight effusion of a colourless fluid between the membranes of the brain.

The sinuses of the brain were much gorged with blood in the greater number of instances.

Of the Consistence of the Human Brain.

The brain has been usually described as a pulpy substance. It varies much in firmness in different individuals, and from a variety of circumstances.

The younger a child, the softer is the brain: in a fœtus it is gelatinous. In cold-blooded animals, it is much softer than in the warm-blooded; hence it suffers less from pressure applied to it.

Much has been said respecting the consistence of the brain of maniacs. According to MECKEL, it is harder than in the healthy state. MORGAGNI * found it in some harder, but in others softer than in the healthy body.

I have examined with much attention, the brains of three maniacs, without being able to discover any morbid appearances.

The anatomical investigations of GREDING, HASLAM, PINEL, and others, have proved, that the same morbid appearances are discovered in the brains of maniacs, as in persons who have died from apoplexy, epilepsy or convulsions.

The brain, in consequence of apoplexy, hydrocephalus, and typhus fever, often acquires an unnatural degree of softness, and sometimes it is converted into a substance like custard. This fact has been long known, and the softening is either general or partial. From what I have observed, it is more

* Epist. viii.

commonly partial, and immediately around the extravasated blood, and in the corpora striata.

When the softening is on the surface, the convolutions of the brain are by no means obvious.

The softened portion of the brain often assumes a dirty green or dirty yellow colour, and this softened state is often combined with the growth of a number of small exostoses from the inner table of the skull, which is as rough as a file.

On the other hand, the brain sometimes attains an unnatural and partial degree of hardness and solidity. This has been sometimes observed in the brain of idiots, but, in such, it is by no means a constant appearance. The hardened portion of the brain looks like an inorganic substance; no vessels can be seen in it.

After birth the brain undergoes a striking change in the proportion and consistence of its several component parts, and the evolution of the mental faculties has been stated by Mr Lawrence to correspond with them.

The proportional size of the brain, in respect to the spinal cord, is different in different animals.

In man the brain bears a larger proportion to the spinal cord than in any other animal, and the spinal marrow very much exceeds in bulk any of the nerves connected with it; but the spinal marrow of the horse and ox is much larger in proportion to the brain; and in fishes, the transverse diameter of the brain scarcely exceeds that of the spinal marrow.

The acuteness of the intellectual faculties probably depends on the bulk of the brain; and the force and rapidity of voluntary motion of animals, seem connected with the proportional size of the nerves distributed to the organs of sense.

In those animals which are superior to man in strength, the nerves are larger; and in the classes of fishes and insects, which are remarkable for the acuteness of their feeling, and the rapidity of their movements, the nerves of the limbs are proportionally much larger than in the human body.

The higher orders of animals have the same number of senses as man; but many of the inferior animals are destitute of some of these.

Chemical Analysis of the Brain.

Since my Outlines were published, chemical analyses have been made of the brain and nerves, by VAUQUELIN, THENARD, and Dr JOHN, of which the following is the result, as stated by Dr T. THOMSON.

1. VAUQUELIN some time ago, published an analysis of the brain of animals, from which he concluded, that phosphorus was one of its constituents. This induced Professor JOHN to undertake a sort of experiments upon the brain, nerves, and spinal marrow of calves. (SCHWEIGGER's Journal, vol. x. p. 155.) These experiments induced him to conclude, that phosphorus is not a constituent of the brain; but that it exists in that substance in the state of phosphate of ammonia. Dr THOMSON states, that these experiments do not appear quite conclusive. The subject is perhaps too delicate to be determined by chemical analysis in its present state.

He employed always brain extracted from the animal immediately after death, and quite warm.

The liquid portion of the brain assumed a liver colour when heated. It consisted of albumen, water, and traces of various salts. The solid matter of the brain produces no change in the colour of litmus paper, even when exposed to the air for days. JOHN supposes, that if it contained phosphorus, phosphoric acid would be formed by such exposure. When heated, it gave out the odour of moat; but no fat separated. When all the liquid portion was evaporated, the matter became brown, and at last melted, and was charred. The silver vessel in which the experiment was made, assumed a black colour, indicating the presence of sulphur. The water with which the charry matter was washed, reddened litmus paper. When the water was evaporated, the residuum, treated with potash, yielded ammonia: this residuum being dissolved in water, left a small portion of a substance, which possessed the properties of silica. From the solution, ammonia precipitated phosphate of lime. Left to spontaneous evaporation, it yielded crystals of sulphate of potash, common salt, and phosphate of magnesia. The free acid present was the phosphoric. The

brain, when triturated with potash, gave out ammonia; and ammonia was likewise obtained, when a mixture of brain, potash and water, was distilled.

When water is boiled with a quantity of brain, then filtered, and mixed with alkohol, only a little gelatinous matter separates. The alkoholic solution, in a few weeks, deposited crystals, which consisted of a greasy matter, phosphate of ammonia, and common salt. Alkohol separates the fatty matter very well from brain, and the liquid passes readily through the filter when hot.

The fatty matter of calf's brains is white; at the same time, the alkohol dissolves another substance, called by THENARD and VAUQUELIN *Ozmazone*.

The constituents of the cortical portion of the brain of the calf, were as follows:

Water,	75 to 80
Insoluble, cerebral, albumen, with some soluble, ditto,	10
Ozmazone,	
Fatty matter,	
Phosphate of Lime,	
Phosphate of Soda,	
Phosphate of Ammonia,	15 to 10
Phosphate of Magnesia,	
A Sulphate,	
Common Salt,	
Trace of Phosphate of Iron,	
	100.

The medullary portion of brain contains the same constituents as the cortical; but the proportion of fatty matter is greater, and the celebral albumen, when treated with alkohol, is harder and more fibrous. Traces of silica are also found in it.

The medulla oblongata contains the same ingredients as the medullary portion of the brain, but less water and more albumen.

The same observations apply to the thalamus nervorum opriorum, the cerebellum, and the nerves.

Of the Coats of the Brain.

In all red-blooded animals, the brain has three coats, the *Dura mater*, the *Arachnoid Coat*, and *Pia mater*.

The dura mater is fixed very intimately to the internal table of the skull, by a number of bloodvessels and cellular threads, especially at the sutures, and hence has been called the *Periosteum of the internal table of the Skull.*

The dura mater, the supposed origin of all the other serous membranes, gives a general covering to the brain and nerves connected with it.

It is of a firm and compact texture, of a leaden, or rather purplish colour, and is made up of tendinous-like fibres, which differ much in size, and are disposed chiefly in a longitudinal direction on its outer surface; but, on its inner surface, the greater number of the fibres are transverse, and these are crossed by fibres following different directions.

It is about a line in thickness, nearly opaque, and remarkably tough. When the skull-cap has been removed, its outer surface appears rough and flocculent; but, on its internal surface, it is very smooth, and has a glistening appearance, being besmeared by a serous fluid, and hence is very readily separated from the subjacent arachnoid coat.

Though this membrane, in its natural state, possesses but a small share of elasticity, or extensibility, it sometimes admits of considerable extension from disease, as in those cases in which a large quantity of water has been collected within the ventricles of the brain, in consequence of the disunion of the bones of the skull. Perhaps, in this instance, there is an addition of matter to the membrane, as of muscular substance to the womb when it is extended from pregnancy.

In consequence of extension from water accumulated within the brain, it has been occasionally ruptured *.

The dura mater also lines the base of the skull. It insinuates itself into the foramen cæcum of the frontal bone, and is firmly fixed into the crista galli and the cribriform plate of the ethmoid bone; and it forms sheaths for the nerves and

* Vide Med. Chir. Trans. of London, vol. viii. p. 51.

bloodvessels which pass through the cribriform plate. It lines also the foramina optica, the orbits, and covers the optic nerve, as far as the sclerotic coat of the eye. It lines the sphenoidal bone, and forms a passage for the internal carotid, and ophthalmic arteries and nerves, passing through the foramen lacera anteriora.

The dura mater extends backwards over the grooves on the upper surfaces of the partes petrosæ, forming the upper petrosal sinuses. It lines the meatus auditorius internus, and it then lines the os occipitis, covers the lateral and occipital sinuses, and commonly divides the foramen lacerum into two parts, though, in some cases, the division is bony.

The dura mater is also continued downwards to the cuneiform process of the os occipitis, from which it passes downwards into the spinal canal, to form a sheath for the spinal marrow.

An elongation of the dura mater extends from the front to the back-part of the head in the middle line of the skull, and divides, to a certain extent, the hemispheres of the brain.

This portion of the dura mater is but narrow in the forepart of the head where it is fixed to the sphenoid and ethmoid bones; but as it sweeps backwards over the corpus callosum it becomes gradually broader, so as somewhat in form to resemble a sickle; and hence it has been called *Falx Cerebri.*

The upper convex and thicker border, between the layers of which the superior longitudinal sinus is placed, is fixed and connected with the middle of the frontal parietal, and the middle and perpendicular ridge of the occipital bone, and is at length fixed to the middle horizontal partition interposed between the posterior part of the cerebrum and cerebellum, called *Tentorium Cerebello-superextensum.* The inferior edge is not connected with any part, and between its layers there is a venous canal called *Inferior Longitudinal Sinus.*

The sweep of the under concave part of it corresponds in form with the corpus callosum, but is not fixed to it.

There are sometimes apertures of considerable size in the falx cerebri.

I met with one instance, in which there was an aperture of

an oval shape, about two inches long, through which a process of the brain passed. In another instance, the falx was wanting *.

In the lower animals, the length and breadth of the falx are much less than in man.

In many animals the falx is osseous, as in birds.

The dura mater is supplied with blood from the external and internal carotid arteries, and also from the vertebral arteries. But we cannot trace nerves along it, or into its substance.

Upon the upper surface of the dura mater, in the vicinity of the superior longitudinal sinus, there are small bodies, which, generally speaking, are about the size of pins' heads, which vary much in size and situation in different individuals. These have been described by PACCHIONI as being *glandular*, by others as forming *a part of the absorbent system*; but it has not been ascertained that they are glandular, or that they constitute a part of the absorbent system, for we are completely in the dark as to their nature.

The tentorium cerebello-superextensum, or tranverse middle septum, on which the posterior lobes of the brain rest, and which separates these from the cerebellum, is fixed to the grooves and transverse ridges of the os occipitis, to the ridges of the partes petrosæ of the temporal bones, and to the posterior clinoid processes of the sphenoid bone.

Between the transverse septum and posterior clinoid processes, there is an oval-shaped aperture, where the cerebrum and cerebellum are united.

The falx and the tentorium cerebello-superextensum, and the connected and continuous processes of the dura mater, mutually support each other, and prevent the one hemisphere of the brain and the back part of the brain from gravitating on the cerebellum.

The falx minor of the cerebellum is fixed to the middle perpendicular ridge of the occipital bone, and terminates at the edge of the foramen magnum ossis occipitis.

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* Vide BLUMENBACH's Comp. Anat. by LAWRENCE.

The SUPERIOR LONGITUDINAL SINUS, imbedded between the layers of the dura mater, takes its rise at the crista galli of the ethmoid bone, runs along the upper part of the falciform process of the dura mater, becoming gradually larger as it approaches the back part of the head, and divides, opposite to the most prominent part of the os occipitis, into two lateral branches or sinuses.

The smaller veins of the brain open into the superior longitudinal sinus, at its upper and back part, and their orifices are chiefly directed obliquely forwards.

The right and left branches of the superior longitudinal sinus, called the LATERAL SINUSES, which are imbedded in the grooves of the occipital, parietal, and temporal bones, follow a tortuous course, and at length terminate in the internal jugular vein.

The FOURTH SINUS, or TORCULAR HEROPHILI, is a short canal, situated at the junction of the falx and tentorium, which it passes, downwards and backwards, and joins the lateral sinuses.

The INFERIOR LONGITUDINAL SINUS, lodged in the under part of the falx, is very small, when compared with the upper, and is sometimes awanting.

There are also various sinuses, situated at the base of the skull, which have been named, from their situation or form. These are the SUPERIOR AND INFERIOR PETROSAL SINUSES; the former is situated upon the ridges of the partes petrosæ, and the latter at the roots of the partes petrosæ of the temporal and the occipital bones.

The SPHENOIDAL SINUSES are placed at the sides of the sella turcica.

The CIRCULAR SINUS of RIDLEY surrounds the pituitary gland; it is of a small size, and receives the veins of the dura mater which are in the vicinity of it.

The CAVERNOUS SINUSES begin at the anterior clinoid processes, and extend backwards, in a horizontal direction, at the sides of the sella turcica, and terminate in the superior and inferior petrosal sinuses.

Within these sinuses the *internal carotid arteries* are placed.

The arteries of the anterior part of the dura mater are derived from the ocular artery; those on the middle part from a branch of the external carotid; those of the posterior part from the vertebral arteries; and these arteries are accompanied by veins, which enter the sinuses, at the base of the brain.

The dura mater being a serous membrane, is liable to inflammation, and all other organic derangements peculiar to membranes of a similar description.

The dura mater also lodges the venous sinuses of the brain; and, owing to its tough and unelastic nature, and to the sinuses being lodged in grooves of the skull, or being connected with the falx or tentorium cerebello-super-extensum, these sinuses cannot be extended, so as to compress the brain, or ruptured; and, on the other hand, their opposite sides cannot be compressed, by the weight of the brain, to such a degree, as to interrupt the flow of blood through them.

I have made a number of experiments upon the dura mater of living animals, and invariably found, that a portion of the skull might be removed by the trephine, with impunity; but if the dura mater was cut, the animals, in a short time, became excessively feverish, and generally died in a day or two, from an inflammation of the brain.

Pieces of bone are sometimes formed between the laminæ of the dura mater. I have seen these very large; and, in an epileptic boy, there were pieces of bone of various sizes connected with a newly formed, and very vascular, thin membrane, which lined the dura mater.

Of the Arachnoid Coat.

This very thin coat lines the dura mater. It has been called *Arachnoid*, on account of its extreme thinness and resemblance to a spider's web. It is spread over the convolutions of the brain, but does not penetrate between them.

This thin membrane does not adhere to the dura or pia

mater intimately, and may be detached readily from either, by inflation, especially at the base of the brain, where this coat is naturally detached from the other membranes.

In very early life, this coat is so thin as to be pellucid; and it adheres so intimately to the pia mater, that it can scarcely be separated from it; but in very advanced life, it becomes thicker and semiopaque.

On account of the extreme thinness of this membrane, it is difficult to detect its structure. I am inclined to suppose it a serous membrane; for, like other serous membranes, it forms a bag, without an external opening, and gives a lining to the vessels and nerves; has a smooth surface, which is lubricated by a serous fluid; is subject to the same organic derangements as membranes of that description, and is sometimes thickened. It adheres to the other membranes, and sometimes has been ossified.

There are no vessels proper to this coat, which are of such a size as to admit the red blood. It is yet doubtful, whether absorbent vessels be proper to this coat or not.

The effusion of a watery fluid often takes place between the membranes of the brain, without occasioning any morbid symptom; and hence the presumption that it has taken place slowly.

It is proper to add, that, in comatose affections, I often remarked an effusion, to a considerable extent, between the membranes of the brain, when, at the same time, there was a slight thickening of this coat, which, in colour, very much resembled the mineral called *Opal.*

This membrane covers the veins which enter the superior longitudinal sinus; it descends on each side of the falx, and covers the corpus callosum.

By some authors it has been said to line the ventricles of the brain.

This membrane also incloses the olfactory and optic nerves, and the infundibulum.

Of the Pia Mater.

The third membrane of the brain has been called *Pia Mater*. This membrane varies much as to its thickness and toughness, in different places. In some places it is not thicker than a cobweb, but in others it is of a spongy consistence.

This membrane is very largely supplied by bloodvessels, which pass from it into the substance of the brain.

This membrane not only covers the upper and under surfaces of the brain and its projections, but also enters in between its convolutions, forming processes of a spongy consistence, called *Tomenta Cerebri;* and these tomenta are fixed to the brain by bloodvessels, and fine cellular substance.

Between the middle lobes, at the base of the brain, the arachnoid coat is detached from the pia mater, for the space of a quarter of an inch, under the posterior part of the corpus callosum and fornix.

The most remarkable process or prolongation of the pia mater, is that which is situated under the fornix.

There is a transverse slit in the back-part of the corpus callosum, at which the pia mater enters, to form the *velum*, or *tela choroidea.*

The tela choroidea is a plexus of vessels, adhering firmly to the lower part of the fornix, which it imprints; it is somewhat triangular, being broader behind, and becoming gradually narrower.

The pia mater covers and adheres to the thalami nervorum opticorum, and corpus fimbriatum.

The pia mater also covers the corpora quadrigemina, and involves the pineal gland; adheres closely by many vessels to the under surfaces of the fornix, with which it corresponds in form.

The velum separates under the anterior crura of the fornix, into two small portions, between which there is a passage to the third ventricle; and these two small portions of the velum are united with the anterior and smaller extremities of the choroid plexuses, below which the communication between the lateral ventricles is placed.

In each tela choroidea, there is a large vein, which is directed backwards, and behind the pineal gland; the veins of opposite sides are united, and form a large vein, which discharges its contents into the Torcular Herophili.

In cases of disease, it is very difficult to determine whether the pia mater be inflamed or not. The late Mr Hunter is the only author, as far as I know, who has accurately described the inflammation of this membrane. "When inflammation takes place in parts that have a degree of transparency, that transparency is lessened. This is probably best seen in membranes, such as those that line cavities, or cover bodies in their cavities, such as the pia mater, where, in a natural state, we may observe bloodvessels to be very distinct; but when we see bloodvessels fuller than common, yet distinct, in such membranes, we are not to call that inflammation."

The pia mater receives its blood from the internal carotid, and vertebral arteries.

The larger branches of the veins of the pia mater are situated between the convolutions of the brain: the greater number ascend, and terminate in the superior longitudinal sinus.

The brain occupies the whole of the upper and fore-part of the cavity of the cranium; it is somewhat of an oval shape, and extends backwards to the hinder-head, corresponding in figure to the inner table of the skull, which is impressed by it.

The upper part of the brain is divided into two great parts or hemispheres, as they have been denominated by anatomists; the smaller extremities of which, are directed forwards. These hemispheres are not exactly similar to each other in all respects; and their length is to their breadth as 4 to 3.

These hemispheres are disjoined by a deep fissure, extending from before backwards, in the bottom of which a very white substance is seen, called the *corpus callosum, or greatest commissure of the brain.*

The surfaces of the hemispheres, which are opposed to the falciform process of the dura mater which separates them, are nearly flat, though not destitute of convolutions.

All the parts of the brain are double. It has been commonly described as being symmetrical, so that, if divided in-

to two halves, by a line drawn from the fore to the back part, its opposite sides would be equal; whereas, if the brain be examined with great care, it will be found, that the opposite halves are neither exactly similar as to size nor as to shape, an observation which applies not only to the surface, but also to the internal parts of the brain. Thus, we sometimes observe the convolutions of one side of the brain much more prominent than those of the opposite side. There is also a most marked difference as to the size of the thalami or colliculi nervorum opticorum, and of the corpora striata of the lateral ventricles.

The brain is divided only to a certain extent into two hemispheres, by a fissure; and on examining the bottom of the fissure, after gently pushing the hemispheres asunder, a white body, about half the length of the hemispheres, comes into view, which unites them, and is lost in their substance, and which has been called *the greatest Commissure*, or *Corpus callosum*.

Each hemisphere is greater in length than breadth, slightly and uniformly arched above, irregular beneath, subdivided into three lobes, and flat next the falx.

The anterior lobes rest upon the orbitar processes of the frontal bone. The middle lobe, which is separated from the anterior by the fossa Sylvii, occupies the cavity formed by the sphenoid and temporal bones; and the posterior lobes rest upon the tentorium cerebello super-extensum.

The brain of the ape is divided, like the human brain, into two great hemispheres, which are nearly similar in form and size; these are subdivided into lobes: but the hemispheres are flatter and shorter than in man, and the convolutions are smaller, more equal in size, in figure, and direction, and not so numerous as in man. In the porpoise, however, they are smaller and more numerous.

On the surface of the brain there are many prominences, or convolutions, which correspond with the inner concavities on the inner table of the skull, not unlike the turns of the intestines, but which are not uniform as to breadth, shape, or size.

In some brains the convolutions are large, but in others smaller and more numerous. The convolutions of the human brain are larger and more distinct than in the inferior animals.

But when a considerable quantity of water has been collected within the head, the surface of the brain is uniform; it looks like a bag of water, and, on cutting through this bag, the parietes are found to be composed of the brown and white substance of the brain, *disposed in a horizontal direction in respect to each other*; a proof of the extension of the brain.

The under surface of the brain is much more irregular than the upper one.

The brain, when divided, is found to be neither uniform as to colour nor consistence. It is composed of two substances very different in colour, consistence, extent, and sensibility, and the boundaries between these different substances are well defined.

The outer, or grey part, as it is commonly called, is somewhat of a light-brown or purple colour in the very recent brain, semitransparent, gelatinous, soft, and very vascular; it is softer than the white part; and, when dried, it assumes somewhat of a horny appearance. When examined by the microscope, it is found to consist chiefly of bloodvessels.

Albinus, and also Sœmmering, have proved, that, besides the bloodvessels, there is another substance in the cortical part, which is probably secreted by the bloodvessels; but whether we are to join Malpighi in considering it to be glandular is to me very doubtful.

My Father has proved, that the cortical part always accompanies the white part, and probably forms it. Teidemann has lately endeavoured to controvert this opinion, by stating, that the white part in the fœtus, is formed before the grey part.

Within the grey substance there is an opaque, more firm, and white substance; and upon this substance, there are several large patches of such a yellow colour as ochre would give, and also some parts evidently of a silvery grey hue.

When the white matter of the brain has been dried it loses

considerably in its bulk, and assumes a yellow horny appearance.

It is remarkable, that even in cases of long continued jaundice, occasioned by a diseased liver or spleen, though the skull and dura mater acquire a yellow or greenish hue, the cineritious or medullary part of the brain *scarcely partakes of the same yellowish tint.*

The position of the grey in respect to the white part of the brain varies in different parts of the brain: in the hemispheres it is external, but in other parts of the brain, and in the spinal cord, internal. The white part constitutes the more considerable share of the hemispheres of the brain, and also a portion of the medulla oblongata, and medulla spinalis; and it is more abundant in the human brain than in any other.

The grey part of the brain possesses but little or no sensibility. According to some authors *, it is the seat of the intellectual faculties, and the white matter the seat of sensibility.

Different opinions have been entertained concerning the nature of the white matter. By some anatomists it has been stated, that it consists of a number of small tubes, disposed in a parallel manner in respect to each other; and by Vieussens, Malpighi, my Father, Cuvier, and others, it has been represented as fibrous.

In the section of the recent brain, published by my Father, the fibres are represented as following different directions, which corresponds exactly with Cuvier's description of them, who, speaking of the white substance, has observed, "elle paroit à l'oil composée de fibres très fines, dont les directions varient †."

The fibres of the white part of the brain are seen with the naked eye, by scraping the recent brain in the direction of the fibres, or by putting the brain for eight or ten minutes into boiling oil, or by immersing it in alcohol, or the nitric

* Mr C. Bell, and others.

† Tom. ii. p. 100. Paris 1800.

and muriatic acids diluted with alcohol; and in some cases of the chronic form of the dropsy of the brain, I have seen the fibres of it very distinctly.

Vieussens has thus described the fibres of the white part of the brain. "Alba cerebri substantia quam passim substantiam medullarem imo et aliquando medullam nominabimus, innumeris e fibrillis simul connexis, at veluti plures in fasciculos distinctis conflatur, quod aperte patet dum hæc in oleo excoquitur; illa namque tunc temporis innumeras ex fibrillis, e quibus simul connexis ipsam conflatam esse modo diximus, facile dividi potest. Hujusmodi autem fibrillarum aliæ aliis, dum situm naturalem servant, adeo proxime juxta ponuntur, ubi scilicet glandulosæ nullæ particulæ ipsis interseruntur, ut sensile nullum inter ipsas relinquatur spatiolum et continuum constituant corpus: quemadmodum interiores baculi fibrillæ, licet ipsarum aliæ ab aliis separabiles sint continuum alterum corpus, baculum nempe componunt *."

These fibres, according to Spurzheim, may be traced from the corpora pyramidalia to the tuber annulare; from thence, to the crura cerebri, corpora striata, and substance of the brain; but they do not, in my opinion, follow, when viewed by the naked eye, so regular a course as has been described and represented by Drs Gall and Spurzheim.

In the substance of the white part of the brain, a number of red points, or the orifices of cut vessels, may be perceived; and, upon examining with attention the white matter, a number of fibres, disposed in different directions, may be perceived, and more especially by the aid of magnifying glasses.

The white part of the brain, when pressed between the fingers, has a soapy feel.

The substance of the white part of the brain may be unravelled by pouring water, drop by drop, on a thin slice of it; thus it appears, by the microscope, to be composed of a number of very small globules, and of fibres, united by a viscid mucus; and when the brain has been dried, it loses considerably in its bulk, and acquires a yellowish-brown colour,

* Lib. i. cap. x.

which it acquires from the mucus, the bond of union between its component globules.

The globules form the fibres.

According to De la Torre, the brain and cerebellum, and medulla oblongata, and also the white part of the nerves, are composed of *transparent globules swimming in a fluid.*

Prochaska observes, that both the cineritious and white parts are composed of innumerable round globules, united by a transparent cellular membrane, disposed in right lines, and which round bodies are about eight times less than the red globules.

According to Messrs Joseph and Charles Wenzel, the globules put on *the appearance of cells*, filled by the white substance; and these globules seem to adhere to each other closely by a gelatinous substance. The size of the globules is not uniform in different brains; and they differ as to size in the different parts of the same brain. Mr Bauer perceived, by the aid of his microscope, in the recent human brain, which had been steeped in distilled water, globules proceeding in straight lines from the cortical into the white part; so that the brain has a fibrous appearance. The size of the globules, he observes, varies from $\frac{1}{2400}$ to $\frac{1}{4000}$ of an inch; and they vary in size in different parts of the brain*. The different appearance in the different parts of the brain depends on the size of the globules, and the proportions they bear to the other parts. These globules are united by a gelatinous substance.

In the Philosophical Transactions for 1824, p. 1., a figure is given of the human brain, in a recent state, which had been immersed in distilled water, and which is magnified 200 times. The globules are seen very distinctly arranged in rows: and Fig. 2. of the same Plate, in which the brain is magnified 25 times, shews "the arrangement of the globules in straight lines, which pass uninterruptedly across the cortical substance into the medullary."

* Phil. Trans. for 1818, and 1821, p. 27.

A horizontal section of the hemispheres of the brain, made on a level with the corpus callosum, exposes the greatest proportion of the white to the grey substance,—the former of which assumes an oval shape, and has been called the *Centrum ovale medullare* of VIEUSSENS.

There is a groove, or raphe, extending longitudinally along the corpus callosum, for a reflected branch of the internal carotid artery, the arteria callosa; and, on each side of it, a medullary cord, from which many transverse fibres proceed. A considerable proportion of the upper portion of the hemispheres of the brain has been often removed, without any bad consequences following. It may also be punctured without causing acute pain. Dr WILSON PHILIP removed, by successive slices, the whole of the upper and anterior parts of the brain, without affecting the muscles of voluntary motion; that happened only when the knife was applied to, or approached the organs of the nerves, and of the spinal cord. Mr FLOURENS has stated, that if the lobes of the brain of an animal be removed, it loses the senses of hearing and seeing; and, on the other hand, if the cerebellum be removed, and if the brain be entire, these senses are unimpaired; and that, if one hemisphere be cut out, the sight of the opposite side is lost.

But the above observations have not been confirmed by the dissection of human monsters by BRESCET, who has described one as dumb, not deaf, whose eyes were sensible to light; yet, on dissection, the left hemisphere was found to be imperfect; its external part was wanting; its place was supplied by a transparent membrane.

On cutting down on each side of the corpus callosum, we get into two oblong cavities, placed horizontally, and which Baron HALLER has well named, on account of their figure, *Ventriculi Tricornes*, each of them having three cornua. But it is improper to call these cavities, as their opposite surfaces are in contact, in a sound brain. The lateral ventricles are proportionally much larger in the fœtus than in the adult. This observation applies to these cornua.

The sides of the ventricles are constantly besmeared by a

fluid, which is secreted by the vessels distributed upon the membrane which lines them.

The anterior and posterior cornua of the lateral ventricles, are placed nearly horizontally; the middle cornua descend, and then run forwards into the middle lobes of the hemispheres.

There is often a difference as to the size of the posterior cornua and the right and left ventricles. The ventricles differ much in form in the class Mammalia. The Wenzels have remarked, "Equidem superior eorum pars ad magnitudinem totius cerebri fere eandem habere proportionem videtur, quam superior lateralium ventriculorum pars in homine ad magnitudinem totius ejusdem cerebri habet, sed pars eorum posterior ac inferior ab ea, quæ in homine constans est, structura admodum differt. Primo enim posteriora cornua plane desiderantur *.

The corpus callosum is bent downwards at its posterior part, the continuation of which covers the corpora quadrigemina; and, being continued forwards, forms what anatomists have called *The Fornix*, from its resemblance to a vault; and, when it has reached the anterior commissure of the brain, it seems to end in two crura or medullary cords. The under surface of the fornix is impressed by the arteries of the tela choroidea, which, from their supposed resemblance, in their distribution, to the strings of a lyre, are said to form the *Lyre*.

Between the corpus callosum and fornix, the septum, called *lucidum*, is placed, which separates the anterior cornua of the lateral ventricles. The septum lucidum is narrow before; becomes gradually broader, or is in form triangular; and is composed of two plates of medullary substance.

The plates of medullary substance which form the septum lucidum, may, by inflation, be separated from each other; and, in a few cases, a watery fluid insinuates itself between them. Some authors have described the small space interven-

* Vide Wenzel, De penctitiore fabrica cerebri, p. 196.

ing between these two medullary plates, *as a fifth ventricle.* When water has been accumulated within the brain, the septum lucidum is very often torn; for it is often *reduced to a sort of pulp*, not only in the brain of a young person, but also in the brain of persons far advanced in life, in whom all the parts of this organ are generally much more dense than during infancy; and this remarkable softening of the septum lucidum is not the concomitant of a general softening of the brain, but sometimes it is limited to the septum.

The fornix is the continuation of the corpus callosum and septum lucidum; and has been so named from its resemblance to a vault. It has four crura or pillars, two short anterior, and two longer and posterior, which are placed at a distance from each other; are curved; and, descending into the middle or inferior cornua of the lateral ventricles, form distinct processes, which have thin puckered edges, and have been called *The Corpora Fimbriata*, or by Vicq D'Azyr, *Tænia Hippocampi*, as they are united to the greater hippocampus.

The under part of the fornix is joined to the thalami nervorum opticorum, by a vascular membrane called *Tela Choroidea*, which cuts off the communication between the lateral ventricles, excepting at an oval aperture situated under the anterior crura of the fornix.

The choroid plexuses are formed by small branches of the arteria media fossæ Sylvii. These enter the inferior portions of the middle lobes of the lateral ventricles, and divide into a number of very small branches, which follow a very tortuous course.

The choroid plexuses lie along the lower, broader, and rounder extremities of the hippocampi majores: they afterwards ascend, pass forwards and towards the anterior cornua of the lateral ventricles, and lie over the thalami nervorum opticorum, and corpora striata, becoming gradually narrower.

The choroid plexuses of opposite sides meet at the passage of communication between the lateral ventricles, in a narrow point.

There is *an oval hole*, situated under the anterior part of

the body of the fornix; behind the anterior crura of the fornix and commissura anterior cerebri; on the fore part of the joining of the choroid plexus of the two lateral ventricles of the brain; and over the fore part of the third venticle. Hence, at this place, *the lateral ventricles of the brain communicate with each other, and with the third ventricle.* This aperture has been very particularly described by my Father, in his book on the Nervous System *.

I presume, the reader will be gratified by the subjoined observations, which have not hitherto been published, and which contain my Father's own description of his discovery of the communication between the lateral ventricles. In the course of these observations, he has made remarks upon the state of that foramen, when water is accumulated within the ventricles of the brain, and upon puncturing these.

" All anatomists agree, that there is a communication between the third and fourth ventricles of the brain, and many have alleged, that the two lateral ventricles communicate together, and open into the third.

" But on examining the different descriptions given of these communications, I found them to disagree, and to be without precision; nay, several very accurate anatomists, and of late Dr HALLER, doubted, or altogether denied, that any opening could be shown to lead from the one lateral ventricle into the other, directly or through the third ventricle; for which reason I have caused to be delineated, a communication of the lateral ventricles with each other, and with the third ventricle, which I have demonstrated for fifteen years past (since 1753) in the Anatomical Theatre, and which I observed as follows:

" In 1753, I opened the head of a child about two years old, who died of internal hydrocephalus. Both sides of the brain

* SŒMMERING, VIC D'AZYR, and others, refer to my Father's book for a description of the communication between the lateral ventricles of the brain. MOREAU, the editor of the octavo edition of VICQ D'AZYR, has observed, " Les ouvertures qui établissent la communication des ventricules latéraux avec le troisième, sont décrites dans l'ouvrage publié par MONRO, en 1783. Cet anatomiste célèbre en a donné plusieurs dessins exacts, et il a fait voir combien ces ouvertures sont augmentées par certaines dispositions morbifiques, et principalement par les amas d'eau dans les cavités cérébrales."

were *distended with the water;* but on cutting into one hemisphere, the other subsided.

" This seemed to prove a communicatien of the lateral ventricles, but as the brain was soft, and the dissection made in a hurry, I did not exactly observe the place of it. On looking into practical authors, they I found agreed, that the water almost always occupies both lateral ventricles at the same time: Yet it could hardly, I thought, be supposed, that this was owing to the rupture of the septum, (improperly named *Lucidum*,) and it could still less be supposed, owing to the similarity in the structure of the two lateral ventricles, since we do not often observe similar parts affected with dropsy at the same time. Thus for instance, we very seldom observe a dropsy at the same time in the vaginal coats of both testes. Soon after this, I opened the head of a girl of eight or nine years of age, who likewise had died of hydrocephalus, with the same event, and drew off from the ventricles of the brain near four pounds of water, as all who were present reckoned, for we did not measure the quantity. The whole substance of the brain was unusually hard and tough, and the collection of water I conjectured to be owing to a scirrhosity, which I remarked in the tuber annulare and one of the crura cerebelli.

" After laying open both lateral ventricles longitudinally, I took hold of the corpus callosum, and raising it gently, and with it the septum lucidum and fornix, I observed and demonstrated to Mr J. Monro, Mr Halley, and several students of physic, *a passage large enough in this subject to admit the finger, under the fore part of the body of the fornix, by which the lateral ventricles communicated with each other*, and with the top of the third ventricle.

" That winter, I demonstrated this passage in the body of a malefactor, and have always since found it at the very same place of the brain, whether I examined the sound or the dropsical brain, with the difference only, that in the latter *it was always enlarged.* In all my dissections of the bodies of children who had died of hydrocephalus, (and I have now dissected seven), all the water was lodged within the ventricles.

From which, and from my observing that the most accurate authors have generally found it so likewise, I am inclined to suspect, that some have thought the water to be on *the outer side of the brain, when in fact it was within it*, partly from supposing it impossible that *the very tender substance of the brain could be so enormously extended;* and partly from their not knowing that the brain, *when extended, becomes very thin* *, perhaps more than most other organs, when distended by a like cause. Thus in the brain of the girl of eight or nine years of age, above mentioned, the ventricle was opened before the knife entered above the depth of half an inch; so that unless the scull-cap be very cautiously cut through, the water, by a slight cut or puncture, may be let out, and the dissector hence conclude that it was lodged on the outer side of the brain.

" I cannot help suspecting, that some like inattention, or concretion of the brain to the cranium, has led some to suppose, what can scarcely be conceived, that the brain is frequently and entirely changed into water; at least I think I may venture to allege, that MORGAGNI, in his last work, and others, talk more of this than there seems reason to do. Hence, where water is supposed to be collected within the head, I have always thought, that we *should by no means perforate with a trocar in the usual manner, passing this instrument deep, until the water runs along its sides;* but that, with cautious and repeated strokes of a knife and lancet, we should divide the common teguments and dura mater only; and if the water does not appear, desist. For, if the water be lodged within the ventricles of the brain, to give it a discharge, that organ must be wounded in its medullary, and highly sensible, as well as cortical part; besides, as the water runs off, the brain in collapsing will have its part deranged or tore so greatly, as probably to occasion *instant or sudden death.* Thus I have found, that the septum lucidum and fornix, were torn on letting out the water from the ventricles after death, or as the

* It is obvious from the above, that in cases of hydrocephalus the *brain is extended*, an opinion which Drs GALL and SPURZHEIM have also adopted.

rigid bones cannot by bandage or otherwise, be brought to support the collapsed brain equally, this will be in danger of being broken by the changing the posture of the head; nay, though these immediately bad consequences should not happen, the *distracted fibres of the brain* will scarcely recover their tone; and either the degree of inflammation necessary to cause concretion of the sides of the ventricles, the means nature usually employs to effectuate a cure in dropsical cavities, where the air is admitted, will kill the patient; or, if such inflammation and concretion do not take place, the water will again be collected, or the operation will at best prove only palliative. And, indeed, though I recommend tapping where the water is collected on the outer side of the brain, as sometimes is the case, since all other methods of cure almost always fail, yet, I confess, I should not even here expect much benefit from the operation. For, without saying, that taking off that pressure suddenly to which the brain had been habituated, might have a very dangerous effect, I should apprehend fatal consequences, partly from the tossing of the brain after the operation in the too much enlarged cranium, and partly from the general inflammation of its surface, to cause the above mentioned concretion of the opposite sides of the dropsical cyst, necessary to complete the cure. Further, supposing the patient to survive this inflammation, as the bones will be too large for the brain, and, therefore, not every where nor generally contiguous, these cannot well grow together; and what is also discouraging, after trepanning sound animals, and cutting the dura mater, I have not found, that the letting in the air on the surface of the dura mater and pia mater, has occasioned the adhesion of these membranes, except in the very place where their fibres were wounded with the knife, without which, if we may reason from the analogy of dropsy in other cysts, *the relief will be but temporary* *.

* The truth of these observations of my Father, have been fully confirmed by experience.

Wepfer, Muraltus, Lizars, Le Cat, Home, and others, have punctured the brain; the relief has been but temporary; it became necessary to puncture

" The lower ventricles of the brain have been supposed to communicate in a sound body with the cavity of the medulla spinalis; and some authors, particularly RUYSCH, have found a dropsy of the ventricles accompany one of the spinal marrow; and that on letting the water out from the spinal marrow, the head was drained. The proof at first sight appears decisive and incontestible; yet I think I find just grounds to *deny any natural communication between these cavities;* for, in the first place, the tunica arachnoidea and pia mater, appear to me to shut the fourth ventricle at its lower part, and on pouring in water, or a small quantity of quicksilver, they prevent it from descending into the spine. In the next place, none of the cases of dropsy of the head which I have yet dissected, one excepted, were accompanied with dropsy of the spine; and in that one exception, where water was lodged at the bottom of the spine to the quantity of six ounces, and a still greater quantity of it in the ventricles of the brain, *not a drop of the water of the ventricles ran out on opening the spine*, though the head was held erect on purpose to try the experiment. So that I am persuaded, that, in the case mentioned by RUYSCH, if the water was not collected between the pia and dura mater, the membranes at the bottom of the fourth ventricle over the spinal marrow, where they want the support of the cranium, had burst; just as we find, in the *ascites*, the peritonæum and cellular membranes at the umbilicus, are sometimes rent by the weight of the water. In that case, where the water was collected at the bottom of the spine, forming a disease which was first described by TULPIUS, under the name of *Spina bifida*, I found, with Mr HUTCHISON of Dalkeith, the spinal marrow closely adhering to the back-

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the brain again and again, and the patients, with the exception of the case of which Dr VOSE has published an account, have died.

The father of a patient whom I had attended for a considerable time, was induced to consent to the puncture of the brain of his child, though Dr HAMILTON, and several other physicians, were, like myself, hostile to it. The child died in sixteen hours after the operation. I was requested to examine the state of the brain, and found, that not above a half of the water which had been contained within the enlarged lateral ventricles had been discharged.

part of its sheath from the dura mater, and that again closely to the skin, which was much thinner than common, without the intervention of cellular membranes with fat; so that at first sight, the spinal marrow seemed to be wanting; and cannot help suspecting, that some similar case has given rise to that incredible notion, propagated very generally by many authors, that the spinal marrow is sometimes changed into water; and this again, with the great quantity of water sometimes found in the ventricles of the brain, has led into the opinion of a similar mutation in the brain; but which, in place of becoming softer than ordinary, I have always found harder and tougher in such cases."

The concretion of the spinal marrow to the dura mater and teguments, shews the danger that may attend tapping in the *Spina bifida.*

Between the commissura mollis and thalami nervorum opticorum, the *foramen commune posterius* is placed, which has been said to form a communication between the back-part of the third and lateral ventricles; but it is shut up by the tela choroidea.

The lateral ventricles being fully exposed, the following parts come into view.

In the anterior cornu of each lateral ventricle, there are two very obvious projections, viz. the *Corpus striatum* and *Thalamus* or *Colliculus nervi optici*, and the *Choroid plexus.*

The corpora striata are externally smooth, of a brown colour, and in shape pyriform, broad before, and narrow behind; and, when divided, are found to be composed partly of cineritious and partly of white matter; and hence exhibit, when divided, a striated appearance; but, in some instances, I have observed merely a layer of medullary matter, about half an inch in thickness, extending from the anterior to the posterior surface of the corpora striata.

The corpus striatum, like the rest of the lateral ventricle, is lined by its proper membrane, and water sometimes detaches this membrane from the body of the corpus striatum.

I have often seen a part of the corpus striatum destroyed,

as it were by ulceration, when water has been accumulated within the ventricles of the brain.

The Wenzels have endeavoured to resolve the question, why, in cases of hemiplegia, one or other of the corpora striata is diseased; and why "plurimis in casibus pars colliculi istius posterior longe plus, quam anterior, detrimenti patiatur, aut etiam sola læsa sit, anterioris conditione plane naturali, et intacta permanente?

"Prima questionum ex striatorum corporum structura, et ex cinereæ cerebri portionis conditione solvitur.

"Striata corpora ex cinerea magis, quam ex medullari portione constare, notum est; quin adeo in posteriore eorundem, quæ angustior est, parte nulla prorsus medulla conspicitur; cinerea autem portio ut omnes uno ore anatomici confitentur, et vasis et humoribus plenior, multoque mollior est, medullari substantia: nequaquam igitur mirandum est, partium illarum nexum, vehementibus et durantibus, aut sæpius saltem recurrentibus sanguinis in capite congestionibus, nimia vasorum sanguiferorum impletioni debilitari; inde impetuoso sanguinis affluxui resistere minus posse, quo vasa rumpantur sanguinisque in ipsam striati corporis substantiam effusio locum habeat, fiatque ut partis istius destructio evitari non possit, quæ tamen pro effusionis et gradu et tempore diversa est.

"Responsio ad secundam quæstionem petenda nobis esse videtur ex structura striatorum corporum, atque e plexu choroideo.

"Quo magis videlicet striatum corpus retrorsum versus inciditur, eo minus medullaris substantia invenitur, et postrema ejusdem angusta pars ex sola, ut supra jam adnotavimus cinerea constat portione; pars ergo striati corporis posterior vasis plenior, sed et mollior est, atque vi expansivæ magis, quam pars ejusdem anterior, cedit.

"Plexus choroideus, cum suo, quem capite præcedente fuse descripsimus, glomo immediate posteriori angustæ striati colliculi parti, et ex parte etiam colliculo optico adjacet; vasa admodum multa ad striatum corpus emittens, vicissim ejusdem venas recipit: si ergo et copiosa, et ex parte etiam ma-

jora, quæ plexum choroideum formant vasa, tum copia, tum vi sanguinis ad caput affluentis atque in eo retenti, aut diutius aut vehementius extenduntur : tum ibi, ubi minima resistentia atque plurima sunt vasa, disruptionem accidere concipi potest, atque is ipse locus est; pars posterior striati corporis, atque plexus choroidei glomus.

" Cum hoc congruit, quod et CALDANI, et nos observavimus, videlicet, in casibus hemiplegiæ, cum destructione striati corporis, plexum choroideum, præsertim in glomi ejusdem loco disruptum esse *."

The thalami nervorum opticorum intervene between the posterior parts of the corpora striata, and are of a white colour externally, but there is a quantity of cineritious substance in their internal substance.

The inner surfaces of the thalami nervorum opticorum of the corresponding lateral ventricles are flat, and united by a soft transverse plate of medullary substance called the Commissura Mollis.

The posterior parts of the thalami, called Tractus Optici, are of a white colour, and flat; they are directed outwards and downwards in the form of a curve; they cross over the crura cerebri, and at length terminate in the thalami nervorum opticorum.

There are two tubercles connected with the lower portions of the thalami nervorum opticorum, which have been called by SANTORINI *Corpora geniculata*: they consist chiefly of white matter.

The greater part of the tractus opticus is concealed by the middle lobes of the brain, excepting about an inch of the anterior portion.

Under the commissura mollis, and between the thalami nervorum opticorum, there is a deep fissure, called the *third ventricle*; and a funnel-like cavity, called *infundibulum*, runs downwards and forwards, and is fixed by its narrow extremity to the pituitary gland.

The infundibulum is about half an inch long.

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* Vide J. and C. WENZEL, De Penitiori Structura Cerebri, p. 107, 108.

The *Pituitary Gland*, or *Hypophysis*, is a small oblong-shaped body, which is inclosed by the dura mater, and situated in the tela sphenoidalis; it is greyish without, and medullary within; and very different as to hardness in different specimens.

The size of this substance varies in persons of different ages: its bulk is not proportioned to that of the other prominences of the brain, and bears to these a different proportion in different individuals.

The greatest diameter of this substance is the transverse, or from side to side; the less from before backwards. The upper surface in early life is convex, in middle life it is nearly level, but in old age concave.

This substance is of a brownish red colour in the fœtus, but in consequence of age it becomes much paler, and the appearance of the cineritious substance is scarcely observable.

When water has been accumulated within the ventricles, it assumes somewhat of a yellowish hue.

In the ox and horse, the glandula pituitaria is proportionally much larger than in man.

There are two transverse medullary cords bounding the fore and back part of the third ventricle; the one passes immediately before the short anterior crura of the fornix, and unites the corpora striata: this has been called *Anterior Commissure;* and, at the posterior part of the third ventricle, under the root of the pineal gland, there is a similar, though rather shorter cord, called the *Posterior Commissure.*

In the descending cornua of the lateral ventricles, besides the longer posterior crura of the fornix, there are two rounded bodies, which are joined to the posterior extremity of the corpus callosum: these are small at their origin, become considerably larger as they descend, and at last terminate in a round extremity, which occupies the lower portion of the descending cornu: they have been called *Pedes Hippocampi.*

The inner edges of the *hippocampi* is serrated, and the serræ are most distinct in quadrupeds.

The posterior cornua of the lateral ventricles become gradually narrower as they pass backwards: they describe small

portions of a circle outwardly, and their extremities, which are reflected inwards, so as to be about two inches distant from each other, terminate in a sharp point, called by the French, *Ergot.*

In the inferior animals the posterior cornu of the lateral ventricles is awanting.

According to some authors a fluid is contained within the ventricles, which has been supposed to equalize internal pressure. But I do not think that such a fluid can be said to exist; the sides of the ventricle are merely moistened, in a recent and healthy brain.

The corpora *quadrigemina*, or *nates* and *testes*, appear at the back of the third ventricle, and are in part covered by the pineal gland, and vascular web in which it is enveloped.

The superior and anterior substances, called *Nates*, are somewhat oval-shaped, and are larger than the inferior rounded bodies, called *Testes*. These four rounded bodies cover the passage from the third into the fourth ventricle, and are proportionally larger in the inferior animals than in man.

WISEMAN's observations upon wounds of the brain led him to conclude the brain to be *insensible*,—an opinion which has been confirmed by the latest experiments of FLOURENS, who states, that the brain or cerebellum, of living animals, may be pricked or cut, without exciting muscular contraction, and without causing pain; but if the corpora quadrigemina be pricked, the animal is thrown into agitation, and the more so, the nearer the instrument is pushed to the medulla oblongata.

The *glandula pinealis* is of a light red colour, in form like the tongue, with the narrower end directed backwards. It lies over the corpora quadrigemina, and is involved in the tela choroidea. The pineal gland is fixed to the posterior commissure, by two long processes of white matter, and which gradually become smaller, as they advance forwards, to the inner side of the thalami, and anterior crura of the fornix.

In the centre of this gland, there is always, after puberty, a sandy substance, of a yellow colour, the proportion of which varies in different cases.

Different opinions have been entertained as to the seat of the centre of sensation. It is not situated in the upper part of the hemispheres, as considerable portions of these have been lost, without occasioning a diminution of the sensitive faculty; hence the seat of sensation has been supposed to be placed in the deeper parts of the brain, with which all the nerves communicate.

The pineal gland has been said by DESCARTES to be the seat of the soul.

SŒMMERING has supposed the fluid in the ventricles to be the most important part of the organ, with the parietes of which the greater number of the nerves seem to be connected. But I doubt whether there is a fluid within the ventricles: my observations upon the very recent brain lead me indeed to a different conclusion. I have observed, on examining the brain of executed criminals, while yet warm, and only two or three hours after death, that the inner surface of the ventricles was merely bedewed by an aqueous fluid; in a few only was there as much as a tea-spoonful of fluid; and it may be added, that repeated dissection has convinced me, that an aqueous fluid may be collected within the ventricles of the brain, without giving rise to any symptom, which, before death, could excite a suspicion of its existence.

Of the Prominences in the Under Surface of the Brain and Cerebellum.

Each hemisphere has by anatomists been divided into three lobes: these are conspicuous, upon examining the base of the brain.

The lobes of the hemispheres are unequal as to size; the anterior, which is the largest, consisting of about one-half of the whole hemisphere.

The under surfaces of the anterior lobes are somewhat excavated, bearing the impressions of the orbitar processes of the frontal bone; and on each side of the longitudinal line, which separates the hemispheres, there is a projecting convolution.

The anterior and middle lobes of the brain are separated by a deep fossa, named *Fossa Sylvii.*

The middle or the most prominent lobes are lodged in the temporal fossæ, and the boundary between this and the posterior lobe is not well defined.

The olfactory nerves, which are flattened, may be observed passing forwards, within distinct grooves of the brain, and terminating in an oval-shaped prominence, which lies on the crista galli of the ethmoid bone.

There is a cavity between the middle lobes of the brain, in the fore-part of which there are two white rounded cords, the optic nerves, which are united by a transverse portion.

About one-eighth of an inch behind the decussation of the optic nerves, a small reddish funnel-shaped substance is seen, which is connected, by its smaller end, to the *glandula pituitaria*, which is lodged in the sella turcica of the sphenoid bone.

There are two white bodies, called *Corpora albicantia*, about the size of a garden-pea, which are situated about a quarter of an inch behind the infundibulum. On each side of the corpora albicantia, there is a rounded prominence, the crura cerebri, streaked by a number of furrows, which pass obliquely downwards and inwards, the fore-part of which is concealed by the middle lobe of the brain, and the posterior portion ends in a substance laid transversely across the brain, called *Tuber annulare*.

A brown or black dark coloured substance, is found in the centre of the crura, which has been called *Locus niger crurum cerebri*.

Besides the lamina of dark grey substance, I have observed a number of spots of a black substance, in the vicinity of the lamina of dark grey-coloured substance.

Of the Cerebellum.

The cerebellum occupies the inferior cavities of the occipital bone, and is placed below the posterior lobes of the brain, and lies somewhat like a bridge over the superior surface of the medulla oblongata, but is not in contact with it; for the fourth ventricle intervenes.

The cerebellum is divided, like the brain, into two great parts or hemispheres, by its falciform process of the dura mater; and the space between is called the *commissure.*

This organ, in the adult, is about the eighth or ninth part of the brain in weight. It bears a much smaller proportion to the brain in a child than in the adult; for in the former it is not above the sixteenth part of the weight of the brain.

According to the WENZELS, the greatest change, in the proportions which the cerebellum bears to the brain, takes place during the first four years of life. In extreme old age, the cerebellum bears to the brain the proportion of 1 to 7, or 1 to 8. In the inferior animals it is proportionally larger, and lobulated.

The cerebellum is in form somewhat oval; it is rather flattened above, rounded below, and proportionally much broader than the brain.

The long diameter of the cerebellum is transverse, and about four inches; but it varies in form, at different periods of life: according to the WENZELS, "quo minores ætate sunt subjecta, eo arctius ambo cerebelli dimidia, invicem sibi acclinantur."

The cerebellum presents a laminated surface. The laminæ are between a line and a line and a half, in thickness, and are disposed in a concentric and regular manner, in respect to each other; they are long and prominent behind, and shorter before; and there are grooves between them, into which the pia mater insinuates itself.

The number of laminæ is between 90 and 100, in most cases.

The cerebellum of the ape tribe is much liker to that of man than in the other inferior animals.

On the anterior and middle part of the upper surface of the cerebellum, there is a process or elongation of the cerebellum, called its *Vermiform process.*

Each of the hemispheres is subdivided into small lobules. The cerebellum is composed of grey and white substance; and the white matter seems, when the cerebellum is cut vertically, near to its middle line, to be distributed through

it, somewhat like the branches of a tree; and in the middle of the trunk of the white matter, there is a small body, of a light brown colour, bordered by a serrated edge of a darker colour, to which the term *Corpus dentatum* has been given.

This substance is not exactly uniform in its colour, and *appears of different breadths, according to the section that is made.* If the section be made obliquely outwards from the middle line, between the hemispheres of the cerebellum, it looks broader than if the cut be made in a direction nearly parallel to the space between the hemispheres of the cerebellum.

The cerebellum is covered by the same membranes as the brain.

The cerebellum is joined to the cerebrum by two medullary cords, which are inserted into the substance of the cerebellum, and their fibres are intermixed with those of the medulla oblongata.

There is a ventricle called the *Fourth*, placed between the cerebellum, pons Varolii, and upper part of the medulla oblongata, and which extends from the testes to the posterior part of the cerebellum.

In the under part of the fourth ventricle, there is an angular impression, which has been supposed to bear a resemblance to a writing-pen, and is hence named *Calamus scriptorius.* This ventricle is shut by its choroid plexus.

The results of the experiments of Flourens on the cerebellum are very singular.

When a slice of it was removed, great weakness followed; and this was the greater, the greater the quantity removed, which probably depends upon the sympathy between the several parts of the nervous system. When the half of the cerebellum had been removed, the animal (a pigeon) staggered much, though it heard, and saw, and did not seem to suffer pain; and when still more of the cerebellum was removed, the animal could not support itself even with the aid of its wings and tail; hence Flourens infers, that the *cerebellum is the regulator of the locomotive faculty.*

Rolando, on the other hand, compares *the cerebellum to a*

voltaic pile, which secretes a fluid similar to the *galvanic;* the medulla oblongata as the conductor in which the fluid is accumulated, and the nerves as the media transmitting the fluid to the muscles.

It had been observed by ARETÆUS, that a palsy of one side of the body originates from an organic derangement of the opposite side of the brain; and the observations of the decussation of the fibres of the opposite side of the brain and medulla oblongata, by MISTICHELLI, SANTORINI and MORGAGNI, seemed to afford a ready explanation of this circumstance. But more modern investigation has shewn, that *a palsy also originates from a disease of the same side of the brain.*

To put this in a clear light, I have subjoined a short abstract of the cases which fell under the notice of those distinguished anatomists Messrs WENZEL.

The WENZELS have described the case of a woman eighty-six years of age, who had laboured under *palsy of the left side.* On dissection, a good deal of blood was found in the *right ventricle;* the corpus callosum was pushed over to the left side; the septum lucidum was torn, and the fourth ventricle was filled by the extravasated blood. On removing the extravasated blood, the *right corpum striatum and thalamus nervi optici,* were destroyed in part.

I saw a case precisely similar to the above, along with the late Drs GREGORY and RUTHERFORD, excepting that the patient was a man of fifty years of age. The WENZELS have also published the case of a short-necked fat clergyman, whose *right side* became paralytic after an attack of apoplexy. He stammered when he spoke, and articulated indistinctly. A great part of the *left corpus striatum* was found reduced to a pultaceous mass, by the effusion of blood into its substance.

In another case, the *left leg* became paralytic; the patient lost the power of speech and all feeling. In *the left hemisphere of the brain, there was a cavity 2 inches long, and* $2\frac{1}{2}$ *broad,* filled by extravasated blood. It extended through the substance of the corpus striatum and thalamus nervi optici, and the surrounding brain was soft and pulpy.

The WENZELS have also published the case of a man of sixty-seven years of age, whose *right and left leg, and left side of the face, were paralytic* before death. They state, that, on dissection, the vessels of the dura mater and of the *left hemisphere, were turgid with blood*, and discoloured, in consequence of extravasation of blood below it, which covered the whole hemisphere; so that instead of being convex, it was concave on its upper surface. The left corpus striatum and thalamus nervi optici, were paler, and less than the right.

The above cases, detailed by gentlemen possessing an intimate knowledge of the structure of the brain, demonstrate the difficulty of arriving at an accurate knowledge of the functions of particular parts of that organ. From the above instances, and from others to be found in WENZELS' book, it may be inferred, that palsy *generally* occurs on the opposite side of the body; and as the power of speech was much affected in some of the instances in which the corpus striatum was diseased, some persons might thereby infer that the nerves of the tongue are somehow connected with the corpora striata.

Of the Nodus Cerebri, Tuber Annulare or *Pons Varolii.*

The pons Varolii, which is, as it were, the centre between the brain and cerebellum, can only be well seen by inverting the brain. Its breadth considerably exceeds its length; it is externally of a white colour, beneath which there is a cineritious substance, and is formed by the union of four columns, the crura cerebri and cerebelli, which form a sort of crescent or bridge; the fore-part of which is arched, and the back-part, next the medulla oblongata, is concave.

On the surface of this substance, there are a number of furrows disposed transversely, about a line distant from each other, which run in a direction parallel to the anterior and posterior edges of this substance, and to each other; and these furrows are crossed by a deep depression, which lodges the basilar artery, formed by the conjoined vertebral arteries.

The tuber is imbedded upon the back-part of the body of the sphenoid and cuneiform process of the occipital bone.

Upon removing a portion of the surface of the tuber, in the direction of its greatest diameter, we meet with alternate streaks of brown and white matter, disposed in a transverse direction; but on going deeper, the fibres are placed in an oblique direction, and in the direction of the crura cerebri.

Of the Medulla Oblongata.

The medulla oblongata connected with the tuber annulari, is somewhat in shape like a Florence flask; the broader end of which, next the tuber, is somewhat contracted, and seems as if it had been begirt by a cord.

On each side of the medulla oblongata there is a projection, which has been named improperly *Corpus pyramidale.*

On introducing the handle of the scalpel into the depression in the middle of the medulla oblongata, and separating the corpora pyramidalia, the decussation of the fibres of the corpora pyramidalia of opposite sides may be distinctly observed.

From the medulla oblongata, the spinal marrow or spinal cord is continued.

On the outer side of each pyramidal body, there is a projection in shape somewhat like a small olive, divided longitudinally, which has been called *Corpus olivare:* its long diameter is directed upwards and downwards.

On shaving down the corpus olivare to a level with the medulla oblongata, we find a light brown coloured substance, with a serrated edge of a darker coloured substance, which has been called *Corpus dentatum.*

To the portions of the medulla oblongata, behind the corpora olivaria, the names *restiformia* have been applied. The medulla oblongata is a very important part of the nervous system, for when compressed by effused blood or other causes, death speedily follows. This probably is owing to the nerves proper to those bowels on which life more immediately depends, being connected with it.

Behind the corpora restiformia, the smaller pyramidal bodies are placed.

The case published by Mr Lawrence *, of a child born without a brain, that lived for four days, is strong evidence of the importance of the medulla oblongata. We are informed, that the spinal cord was continued about an inch above the foramen magnum; and as all the nerves of the head from the fifth to the ninth pair were connected with this tumour, it was undoubtedly a part of the medulla oblongata. Fodere' has endeavoured to prove, that pressure on the brain or cerebellum, causes stupor or apoplexy, from its influence upon the medulla oblongata; for when the brain or cerebellum are compressed *laterally* no such effects follow.

In the course of my description of the brain and cerebellum, I have introduced a few observations relative to the functions and organic derangements of particular parts of these very important organs, rather with the view of exciting further inquiry, than from a conviction of our having as yet arrived at a distinct knowledge of their several functions.

I conceive, that there is so great a connection, and so striking a sympathy, between the contiguous parts of the brain and cerebellum, and also between the distant parts of these organs, that the partial removal of a part of the brain cannot disclose its particular function; the violence done may produce a general or indirect, as well as a specific or direct effect.

The above circumstance may account for the different effects which have been observed to result from organic derangements of the brain or cerebellum. I have now for twenty years devoted much attention to this department of morbid anatomy, have carefully compared the symptoms which preceded death, with the appearances which presented themselves at dissection, but have as yet made but little progress in this difficult investigation.

Within these few years Rolando, Le Gallois, Mr Brodie, Dr Wilson Philip, Mr C. Bell, Majendie, Flourens, Serres and others, have made many experiments upon living animals, but with different results; so that I still hold that

* Med. Chir. Trans. of London, vol. v.

the physiology of the different parts of the brain is involved in great obscurity.

How can we reconcile our supposed notions as to a knowledge of the functions of the brain, with the notorious fact, that a large quantity of water is sometimes accumulated within the brain, when there has existed no one symptom which denoted its presence, excepting the increased volume of the head?

Of the Bloodvessels of the Brain.

The brain receives a large supply of blood by four arteries, called the INTERNAL CAROTID and VERTEBRAL ARTERIES.

According to the calculations of HALLER, one-fifth part of the whole blood is sent to the brain, which he stated to be about the fortieth part of the body.

But this estimate, according to my Father, is too great: in his opinion, only one-tenth or one-twelfth of the whole blood is sent to the brain.

According to Mr BAUER's microscopical observations, every part of the brain has innumerable bloodvessels, which are of considerable size towards the centre; but branch out to an extreme degree of minuteness, even less than the half diameter of a red globule with its colouring matter; and although reduced to that size, the fluid they carry is red. Their branches are accompanied by *vessels of still less diameter, having valves*, which are at short distances. These minute vessels, according to Sir E. HOME, *must perform the office of lymphatics*. They carry, according to him, the absorbed matter into the superior longitudinal sinus.

OF THE INTERNAL CAROTID OR CEREBRAL ARTERY.

The INTERNAL CAROTID ARTERY, follows a tortuous course upon the rectus capitis major muscle, before entering the carotid canal.

The artery having passed through the above canal, is directed upwards; then turns horizontally; enters the cavernous sinus, and perforates the dura mater, at the side of the anterior clinoid process of the sphenoid bone.

This artery sends small *branches* to the dura mater, and to the cavernous sinus; and also gives off small *branches* which accompany the third, fourth, and fifth pairs of nerves.

When the internal carotid artery has perforated the dura mater, it sends off the OCULAR, or OPHTHALMIC ARTERY.

The other, and smaller branches of the internal carotid arteries, are distributed upon the optic nerve, the infundibulum, and the choroid plexuses.

There are two other large branches of the internal carotid artery, the arteriæ anteriores cerebri, and the arteriæ mediæ fossæ Sylvii.

The ARTERIÆ ANTERIORES CEREBRI, are disposed in a parallel manner in respect to each other: they run forwards along the under parts of the anterior lobes of the brain, and communicate by means of a transverse canal.

Each branch is afterwards subdivided into two branches: the smaller is spent entirely upon the anterior lobes of the brain; the larger is reflected backwards along the corpus callosum, and is divided into a great number of small branches, which anastomose repeatedly with the smaller branches of the former artery: many of the smaller branches dip into the substance of the brain, and supply its cortical and medullary part.

The ARTERIÆ MEDIÆ CEREBRI, or arteriæ mediæ fossæ Sylvii, are larger than the arteriæ anteriores. These arteries are lodged in the fossæ Sylvii, and extend obliquely outwards: their innumerable branches supply the middle and posterior lobes of the brain, and anastomose with the branches of the anterior arteries, and also with those of the vertebral arteries.

A few of the smaller branches of these arteries perforate the substance of the brain, supply the anterior cornua of the lateral ventricles, and also concur in forming the choroid plexuses.

The brain also receives blood by the medium of the vertebral branches of the subclavian artery.

The VERTEBRAL ARTERIES, after having entered the head, detach large branches, which join with similar branches of

the *anterior artery* of the brain, and form an *arterial circle* around the sella turcica, which has been named the ARTERIAL CIRCLE OF WILLIS.

The ascent of the blood to the head, and tortuous course of the arteries of the brain, tends to diminish the impetus of the blood sent to that delicate organ. That this is the purpose of Nature, appears more evidently, by examining the distribution of blood in graminivorous quadrupeds. With the internal carotid arteries of such animals, there is a substance connected, which was observed by GALEN, and called by him the *Rete mirabile*: it consists of a very great number of small serpentine vessels, which are afterwards collected at the side of the sella turcica into a trunk. According to my Father, the *vertebral* arteries also form a *rete mirabile.*

My Father observes, " Every individual artery or vein within the head is not always of the same size, nor does it always contain the same quantity of blood; and, of course, the arteries within the head are immoveable, or want pulsation, or are unsusceptible of inflammation: For, while the heart is performing its systole, the artery here, as elsewhere, may be dilating; and, in the mean time, a quantity of blood, equal to that which is dilating through, is passing out of the head by the veins.

" Neither does it follow, from nearly the same quantity of blood being at all times contained within the head, that the opening the arteries or veins on the outer side of the head, or in the limbs, can be of no service in the cure of apoplexy, or inflammation of the brain: For although, by venesection or arteriotomy, we cannot diminish the quantity of blood within the cranium, we can diminish the force with which it is impelled into it."

Of the Veins which correspond with the Branches of the Internal Carotid and Vertebral Arteries.

The larger veins of the brain do not follow a similar course with the arteries, but pass between the convolutions of that organ, and terminate in the *venous sinuses*, with their orifices directed obliquely forwards.

The principal venous sinus has been named the *Superior Longitudinal*, the situation of which has been above described. It divides, opposite to the middle of the occipital bone, into the *Lateral Sinuses*. The blood from the lateral ventricles, choroid plexuses, corpora striata, and septum lucidum, flows into the *Torcular Herophili*, and from it into the beginning of the lateral sinuses; and from the lateral sinuses into the internal jugular veins.

The veins of the dura mater accompany the arteries of that membrane, and terminate in the external or internal jugular vein; and a few of the veins open into the sinuses of the brain.

The terminations of the small veins in the sinuses are not directed backwards and downwards, towards the heart, but are turned upwards and forwards; hence, should the blood be pushed backwards from the veins of the neck into the sinuses, the sides of the small veins, from their oblique passage through the dura mater, are compressed and shut, before their blood reaches their open mouths within the sinuses. Hence, even although the blood should regurgitate from the jugular veins, the smaller veins of the brain cannot be distended; and even a small part of an injection thrown into the sinuses, does not find its way into the smaller veins of the brain and cerebellum. Hence the pressure acts like a ligature upon a vein; so that the flow from the small veins into the sinuses is stopped or retarded only, until the pressure on the jugular veins is removed.

In short, the uses of the structure described are, 1*st*, That when, by a sudden or violent action of the muscles of expiration, or of the muscles of the head and neck, the blood is repelled in the cavæ, or internal jugular veins, the impulse may not be communicated to the blood in the small and tender veins of the brain, which would endanger a rupture of these; to confirm which, it may be observed, that, generally, a very small quantity only of any liquor injected into the sinuses enters the small veins of the brain and cerebellum.

2*d*, The dura mater investing the trunks of the veins of the brain and cerebellum evidently strengthens these, and prevents their being easily ruptured.

3d, The falx and tentorium cerebello-superextensum being connected to the angles of the sinuses, prevent the opposite sides of the sinuses from being pressed nearer to each other, or their cavities from being much diminished by the weight of the parts of the brain and cerebellum in different postures, either by an increased impulse of the blood in the arteries, or by water accumulated in the ventricles of the brain, or on its surface.

I subjoin a very brief account of the peculiarities of the brain of the fœtus, from TIEDEMANN's valuable book on that curious subject.

" 1. In the commencement of pregnancy, especially about the second month, the earliest period at which the brain can be rendered perceptible by the action of alcohol, this organ is very small, in proportion to the spinal marrow. In fact, it results from the prolongation upward and forwards, of the two principal cords, the olivary and pyramidal. All its superior part is open; or, more properly speaking, forms a broad gutter, which at once comprehends the third ventricle, the aquæductus Sylvii, the fourth ventricle, and calamus scriptorius. This gutter is uninterruptedly continuous with the canal which traverses the whole length of the spinal marrow.

" 2. The cerebellum evidently originates from the spinal marrow, from the lateral parts of which arises on each side a small flattened cord. These two, at first so distinct and separate that they may be readily parted without laceration, afterwards unite so as to form the roof of the fourth ventricle; then the brain, viewed from above, ceases to represent a gutter; and the laminæ and branches of the cerebellum are formed at a much later period.

" 3. The mass which supports the tubercula quadrigemina equally shews itself in its origin under the form of two thin membranes, which arise from the olivary cords of the spinal marrow, and which, when they cease to be distinct, represent a vault covering a large ventricle, whose successive contraction gives rise to the aquæductus Sylvii.

" 4. The pyramidal cords of the spinal marrow, which take a direction from below upward, and from behind forward, after

having produced two swellings or ganglia, the optic thalami, and corpora striata, each terminate by a lamina which, bent from before backward, and from the side towards the superior and internal part, forms the commencement of the hemisphere of the brain. These membranes, and thin hemispheres, are so small at the second month, that they scarcely cover the corpora striata. In proportion as they increase, they extend backward, and cover, at the third month, the optic thalami; at the fourth, the tubercula quadrigemina, and at the sixth or seventh, the cerebellum. The lateral ventricles result from their inversion.

"5. The medullary fibres of the pyramidal cords, previously to the formation of the tuber annulare, are immediately continuous with those of the crura cerebri, from whence the eye may readily trace them, in the optic thalami and corpora striata, and see them afterwards spreading and radiating in the hemispheres.

"6. The parietes of the hemispheres gradually increase in thickness, in proportion as new strata of cerebral substance are deposited on their surface, and convolutions are not decidedly seen till towards the close of pregnancy *."

CHAP. III.

OF THE ORGANS OF THE SENSES.

By the Senses, we acquire a knowledge of external objects, which is communicated to the brain through the medium of the nerves.

The external senses are five in number; those of Touch, Taste, Smell, Hearing, and Seeing. To each of these organs

* Vide Lond. Med. Reposit. vol. xv. p. 310.

a peculiar structure is appropriated, which is susceptible of particular impressions, and excludes the agency of all others. The most extended of all the senses is that of feeling, which is common to all animals, and which resides in the extremities of the nerves of the skin. These are guarded and overspread by an insensible substance called *cuticle*, and in the different animals by other insensible teguments, as shells, hair, &c.

The other senses are modifications of the sense of touch, and may be considered as finer kinds of feeling. The nerves proper to the organs of the senses, are of a very peculiar structure, by which they are rendered more fit for receiving various impressions. As the nerves which convey impressions, differ somewhat in consistence and in structure, it has been supposed owing to that cause, that we possess different degrees of sensibility, and different kinds of feeling. Thus, the sense of heat, or cold, or itching, is felt only in the skin; griping in the intestines, hunger and thirst are felt in the mouth and stomach; a sense of lassitude or weariness in the muscles, and a peculiar deep-seated and aching sensation in the bone. As every kind of sensibility is dependent on the nerves, it follows, that the extremities of the nerves, which are distributed on the organ, are the most sensible part of these, and most susceptible of receiving those impressions which they are peculiarly adapted to receive, and to communicate to the brain.

The organs of the senses possess the sense of feeling, as well as the faculties of receiving and transmitting their peculiar impressions to the brain. Thus, a person's eye, though from disease it may be of no use, is still susceptible of the influence of heat and cold. The same applies to the other senses.

SECTION I.

OF THE STRUCTURE OF THE HUMAN NOSE.

The *nose* is formed of hard and soft parts; and it has been divided by anatomists into the radix or upper part; dorsum or middle prominence; and the apex or point.

The sense of smell resides in the terminations of the nerves, which are distributed upon the mucous membrane that lines the nasal fossæ. The nose is of a more simple or complicated structure in different classes of animals. In some, it consists of a great number of plates of bones, which are very much convoluted, so that the extent of surface of the internal nerves is very great, and the acuteness of this sense bears a ratio to the extent of surface, upon which the nerves are distributed. It may also be added, that in the hare, rabbit, badger, and dog, the inferior turbinated bones are of a more complicated structure than the superior; and therefore, though we cannot trace the very minute branches of the olfactory nerves upon the mucous membrane that lines these inferior turbinated bones, it is probable that that is the most sensible part of the nose.

The os frontis, ossa nasi, and ossa maxillaria, form the upper and fore-part of the nose. The os ethmoides, and the ossa unguis, form the upper and lateral parts of the nose. The ossa spongiosa inferiora, os sphenoides, ossa palati, ossa maxillaria superiora and vomer, constitute the under, inner, and back part of the nose.

The soft parts of the nose are, its cartilages, ligaments, membranes, muscles, and skin. There are five cartilages of the nose; the largest of which, and the basis on which the lateral cartilages rest, is placed in the middle.

The middle cartilage also forms a considerable share of the septum narium; and is fixed to the vomer, to the spinous process of the ossa maxillaria superiora, and to the anterior part of the nasal lamella of the ethmoid bone.

The anterior lateral cartilage is bent forwards, and forms what is commonly called the *tip of the nose*, and the posterior forms the wings of the nose.

These cartilages are covered by cellular membrane, fat, a number of sebaceous glands, skin, and by the following muscles, by which they are moved, viz. the compressor narium, and part of the occipito-frontalis, which is fixed into the nose; and the levator and depressor labii superioris alæque nasi

The posterior openings of the nose into the throat are called *Choanæ narium.*

The turbinated processes of the ethmoid bone, and the ossa turbinata inferiora, project into the cavities of the nose : they add much to the extent of the internal surface of the nostrils, and are lined by a spongy and very vascular membrane, which is constantly lubricated by mucus, exuding from a number of pores on the surface of the membrane.

Though the several mucous membranes be said to be of a similar structure, yet they are not all equally prone to disease. Thus *polypi* grow more frequently from the mucous membrane of the nose and of the uterus, than from the other membranes of a similar description. These tumours are soft in substance, semipellucid, and slightly vascular ; they often project through the nostrils, or into the pharynx. Polypi do not create pain, excepting when they attain a large size.

It has been recommended to remove polypi by forceps ; but, on account of the extreme tenuity of the bone, which is covered by the membrane, from which they grow, it is evident that it may be materially injured by their forcible extraction. Besides, polypi are so soft that they are apt to break ; and if a part be left, the tumour rapidly grows again. Indeed it may be observed, that such tumours are very apt to return.

Three passages into the nose have been described by Haller ; an upper passage above the turbinated processes of the ethmoid bone ; a passage between the turbinated processes of the ethmoid bone and inferior spongy bones ; and a passage below the inferior turbinated bones. This last passage being straight, a probe may readily be passed along it into the throat.

The septum narium is composed of the descending plate of the ethmoid bone, of the vomer, and cartilage.

In the fore-part of the nostrils, there are a number of hairs.

The nose is supplied with nerves by the first or olfactory pair of nerves, and by the fifth pair.

The olfactory nerves take their rise by three roots from the

corpora striata, situated in the anterior cornua of the lateral ventricles: they are soft and flattened; are disposed in grooves in the under part of the anterior lobes of the brain, and approach each other as they pass forwards, terminating in an oval-shaped cineritious body, which rests upon the cribriform plate of the ethmoid bone.

In the fœtus of three months, the olfactory nerves are hollow, and of a rounded form.

From these oval-shaped bodies, a great number of small nerves pass through the holes in the cribriform plate. These nerves divide into two fasciculi: the one set is distributed upon the septum narium, upon which they form a very intricate plexus, (my Father was, I believe, the first who accurately described the course of these small nerves *;) and the other part is distributed upon the turbinated processes of the ethmoid bone.

Majendie has lately endeavoured to prove, that the nerves formerly called olfactory, optic, and auditory, are not the nerves of smell, seeing, and hearing; and that the fifth pair, if they do not exercise these functions, are the regulators of the senses above named.

The *ethmoidal, sphenoidal and frontal sinuses*, communicate with the nose, and are lined by the continuation of the mucous membrane which lines the nostrils.

The frontal communicate with the ethmoidal sinuses, which communicate with the nose at its upper and lateral parts behind the os unguis.

The sphenoidal sinuses open into the upper and back part of the nose, and the maxillary sinuses communicate with the nose by an aperture placed nearly in the middle, between the turbinated processes of the ethmoid bone and the inferior turbinated bones.

The air, the vehicle of all odours, when impregnated with certain odours, and inhaled, excites the sensation we call Smelling. To render the sensation the stronger, the internal surface of the nostrils is of very considerable extent; and,

* Vide his description in his Book on the Nervous System.

in general, it may be observed, that the more complex the structure of the nose, the more acute the sense of smell is.

The sinuses which communicate with the nose, tend to render the voice louder and more melodious.

Of the Ductus Incisivus, or *Passage from the Nose into the Mouth.*

This duct opens behind the incisor teeth of the upper jaw, into the mouth; and hence has been called *ductus incisivus* *. The groove for this duct is of different sizes in different skulls; sometimes it is large and very manifest, but on other occasions superficial; and my Father observes, that "in by far the greater number of human subjects, of different ages, I have not been able to find any vestige of such ducts, in the bottom of the nose, or roof of the mouth: But, in a few subjects, I have found them open at both ends, but always very much smaller than in the quadruped. In some of these I passed a bristle, or small probe, very readily from the nose into the mouth."

SECTION II.

OF THE EYE.

The Eye-ball is composed of coats, which contain transparent humours of different densities, calculated for collecting the rays of light into a focus upon the nerve situated at the bottom of the eye-ball.

The eye-balls are situated within the orbits, as also the muscles which move them in different directions, and the bloodvessels, nerves and absorbents proper to the eye-ball and its muscles.

The eye-ball projects beyond the orbits, especially on the outer side, and much more in some animals than in man, as in birds, owing to the orbits being formed like a cone, the

* Vide Plate VI. fig. 4., appended to my Father's Treatise on the Eye.

outer side of which is oblique, but they appear situated deeper towards the nose.

The eye-ball is supported, as upon a cushion, by a quantity of very fine fat; and it is kept in its place by the tunica conjunctiva, the muscles which move it, and the eyelids.

In almost all animals, the eye-ball is somewhat of a rounded form, but it is not in any one animal a perfect sphere.

The human eye may be compared to two segments of a sphere, of which the fore-part, which is pellucid and more prominent, forms a portion of a smaller sphere than the posterior part.

But in the inferior animals the eye-ball does not exactly resemble that of man; it is proportionally broader, and in most birds the cornea is more convex than in the class Mammalia; whereas in the greater number of fishes and cetacea, the cornea is flat, the form of the cornea being adapted to the medium in which the animal lives.

Of the Size of the Eye-Ball.

There is much more variety as to the size of the eye-ball in different animals, and it does by no means bear a proportional size to the rest of the body; as we observe in a child, whose eyes are proportionally larger than those of the adult; and in the elephant and whale, the size of the eye-ball is not proportioned to that of the rest of the body.

The eye-ball of some animals is remarkably small; in the mole so much so, that it was for a long time disputed whether that animal had eyes or not.

In general, it may be observed, that those animals that seek their prey during the night have large eyes.

The eyes of birds are also large, and those of the class of fishes still more so.

There are some men whose eyes are not exactly of the same size; and, generally speaking, the eyes of the male are larger than those of the female.

Of the Position of the Eye-Ball.

The eye-balls of some animals are directed forwards, but those of other animals are directed backwards.

The human eye, that of monkeys, of dogs, and of many birds, is directed forwards, and the eyes of many birds are so placed as to take in a hemisphere. Those of the hare and rabbit are so prominent, and placed so much towards the side of the head, as to enable them to see objects behind as well as before them.

The eyes of most animals may be moved in different directions, upwards, downwards, and sideways; and in the common snail the eyes are appended, like black spots, to the extremities of the horns, in order that the eyes may be moved in different directions: and when the animal cannot move its head, the defect is compensated by the situation and number of the eyes; thus spiders have four, six, or sometimes eight eyes, placed in the front of the head.

Of the Coats of the Eye-Ball.

There are three coats proper to the eye-ball: the Sclerotic and Choroid coats, and the Retina. Besides these, the Tunica adnata passes over the anterior surface of the eye, by which the eye-ball is fixed in its place, and this coat also serves to prevent extraneous bodies from passing from the fore to the back part of the orbit.

A small quantity of fine cellular membrane, in which there are a great many bloodvessels, intervenes between this coat and the sclerotic coat of the eye.

Of the Sclerotic Coat.

The tunica sclerotica is of a greyish-white colour, firm, opaque, tough, elastic, and and composed of a number of small fibres, which cross each other in different directions. These are not obvious in the human eye, on account of the small size of the fibres which enter into its composition, and the very intimate manner in which these fibres are interwoven with each other; but in the *whale* the fibres are much larger, and their progress may be readily traced; they decussate each other, and the intervals between them are filled up by dense and white cellular substance.

The sclerotic coat of fishes is of a firmer texture than that of man or quadrupeds.

In the human body, the sclerotic coat is thicker at its posterior than at its anterior part; and in a young child, this coat is so thin at its fore-part as to be nearly transparent, and in some birds it is soft and pliable.

In the seal it is thicker before and behind than in the middle. Thus the axis of the eye is shortened when the animal sees in air, by bringing the lens nearer to the back of the globe, in order to obviate the strong refraction which the rays of light experience in passing from the thin medium of the air into the eyes.

The sclerotic coat has few vessels proper to it, which are derived from the ciliary arteries; and it possesses but little sensibility.

There are a number of small arteries, named *Ciliary*, which perforate the posterior part of this coat.

There is also a small rounded opening in this coat, which, on its inner side, appears like a circular spot, through which the medullary part of the optic nerve passes.

That portion of the sclerotic coat which lies under the tunica conjunctiva, is of a more brilliant white colour than any other part of the sclerotic coat. This has been imputed to the addition of a covering formed by the union of the tendons of the recti muscles, which move the eye-ball, which have been supposed to be extended over the cornea; but, upon this opinion, it may be observed, that the intermediate spaces between the tendons, are as white and brilliant as the portions of the sclerotic, under the tendons of the muscles; and, besides, my Father has justly remarked, that he found all the tendinous fibres of the recti firmly attached to the sclerotic, at the distance of a quarter of an inch from the edge of the cornea, and no appearance, that any part of them, or that any membrane produced by them, is continued over the cornea.

By experiment on the human eye, he found, that the weight of 54 ounces tore one of the recti muscles, but that it required the weight of 100 ounces to tear its tendon from the sclerotic coat; and when the tendon quitted the sclerotic, there was no

appearance seen, of its fibres passing forwards over the cornea.

In the next place, if the tendons of the recti muscles had terminated, partly in the external layer of the cornea, in such a manner, as to affect it chiefly, they should, by pulling the whole external layer of the cornea backwards, have flattened the cornea, instead of rendering it more convex.

On the inner side of the sclerotic coat there is a thin membrane, of a delicate texture, and of a light brown colour, upon which there are a number of bloodvessels, and which is fixed by a number of processes to the sclerotic coat.

The sclerotic coat, on account of its density and strength, is well calculated for determining the shape of the eye, and for supporting and defending the more essential and delicate parts of that organ.

Of the Cornea.

The cornea forms the anterior transparent portion of the eye-ball.

In fishes and the cetacea, the anterior part of the eye is flat, but in birds remarkably convex.

It is more or less convex, and there is great variety in this respect, in different individuals. In the fœtus it is rather more prominent than in the adult.

When the cornea is too convex, the rays of light are collected into a focus before the retina, and such persons are short-sighted; but, on the other hand, when the cornea is flatter than common, the foci of rays, proceeding from near objects, are formed beyond the retina, and such persons are long-sighted, and can only see objects held at a considerable distance from the eye.

It sometimes happens, that, in the same individual, there is a difference in the convexity of the cornea in the two eyes; thus, a medical gentleman informed me, that one of his eyes acted like a telescope, and the other like a microscope.

The cornea possesses a considerable share of elasticity, but is not so extensible as the sclerotic coat.

The cornea is internally nearly circular, and composed of

alternate concentric plates, between which a very small quantity of aqueous fluid, secreted by the exhalant branches of the arteries, intervenes.

The cornea is composed of plates, the innermost of which are thin and dense, in order to confine the aqueous humour.

The laminæ of the cornea are thinnest in the centre, in order to transmit light more readily, and in order that pressure may more readily render the cornea convex, while we are examining objects very near to the eye.

The thin edge of the cornea lies over the sclerotic coat. Dumours observes, that if the eye be a little putrid, and then put into boiling water, the cornea may be lifted off the sclerotic coat.

The vessels of the cornea are very small, and do not, in a healthy state, admit red blood; in this case, secretion and nutrition is performed by very small vessels.

The component plates of the cornea may be readily separated from each other, and indeed are, during life, often separated by pus or blood.

The cornea is covered by a continuation of the tunica adnata, which is a mucous membrane; and it has been stated to be lined by a thin membrane, which contains the aqueous humour; but concerning the existence of this membrane I entertain doubts.

The cornea, in its sound state, possesses little or no sensibility, but when inflamed, it acquires a considerable share of sensibility; so that when the inflamed or ulcerated cornea is divided by the knife, the patient suffers acute pain.

In the fœtus the cornea is proportionally thicker than in the adult.

When the eye has been inflamed, there are a number of vessels conveying red blood, seen passing across the cornea.

It has been matter of dispute, whether these are the vessels proper to the cornea, which have been enlarged, or are newly formed vessels. The latter of these opinions I hold to be the more correct; and hence they may be removed by the knife, or by external applications.

The cornea, from its peculiar structure, is liable to several organic derangements.

It is very often inflamed, and bloodvessels may be observed passing over it, which is attended by dimness of sight; and, in consequence of that inflammation, it often becomes opake to a greater or less degree. Pustules also sometimes form on the cornea, and when suppuration takes place, the apex of the pustule suppurates. Blood or pus is often collected between the layers of the cornea; or pus is effused into the aqueous humour; or the cornea is very much enlarged, and is at the same time opake, as happens in the disease commonly called *Staphyloma.*

In the eyes of persons far advanced in life, there is, at the root of the cornea, a white line; but this white circle is not peculiar to the old only. I have observed it in a person who was only thirty years of age, who assured me that three of his family were born with it; and I have also seen it as an effect of inflammation,—a fact which confirms the opinion my Father has published, as to its nature, viz. that it consists chiefly of a plexus of small vessels.

The cornea has a great effect in refracting the rays of light; because the rays at the cornea pass from the rarer medium, the air, into the more dense medium, the aqueous fluid; and according to Mr Ramsden, a principal purpose of the crystalline lens is "to correct aberration, arising from the spherical figure of the cornea, where the principal part of the refraction takes place."

Of the Choroid Coat.

This coat forms the second layer or tunic: it is much thinner, and more pliable, than the sclerotic; is of a brown colour, and not unlike that of snuff. The colour is derived from the paint which lines it. This paint is black where it lines the ciliary circle and processes, or where it covers the anterior part and termination of the retina, in order, probably, to suffocate the rays of light which are reflected from the bottom of the eye, upon this part of the retina.

A curious set of chemical experiments on the black pig-

ment in the eyes of oxen and calves has been published by Leopold Gmelin *. From 500 eyes of oxen and calves, he collected 75 grains of this substance. Its colour is blackish-brown. It is tasteless, and adheres to the tongue like clay. It is insoluble in water, alcohol, sulphuric ether, oils, lime-water, and distilled vinegar. It dissolves in potash and ammonia, by the assistance of heat, and is again precipitated by acids. Sulphuric acid dissolves it, and blackens the colour. Muriatic acid produces the same change of colour, but forms only an imperfect solution. Nitric acid dissolves it, and changes its colour to reddish-brown. Twelve and a half grains (Troy) of the pigment were subjected to heat in a glass-tube; a few drops of water came over, holding carbonate of ammonia in solution, a brown oil, and crystals of carbonate of ammonia. The gas extricated amounted to six cubic inches (6.17 cubic inches English), which consisted of

Carbonic acid gas, - -	3·000
Oxygen gas, - - -	0.159
Azotic gas, - - -	2.131
Carburetted hydrogen, -	0.710
	6.000

The water, oil, and carbonate of ammonia that came over into the receiver weighed 5 grains; and the oil alone amounted to one-third of the weight of the whole. The coal remaining in the retort weighed $5\frac{1}{2}$ grains. It consisted almost entirely of charcoal. When burnt it left $\frac{5}{12}$ths of a grain of ashes, which consisted of soda, lime, oxide of iron, and muriatic acid, and probably also phosphoric acid, and carbonic acid. Gmelin conceives that this black pigment approaches the nature of indigo.

The choroid coat is chiefly composed of a number of very small arteries and veins, joined by fine cellular substance; and, after a successful injection of its bloodvessels, it assumes a deep-red colour. This coat is fixed to the sclerotic by fine cellular substance, by bloodvessels and nerves, excepting at

* Leopold Gmelin, in Schweigger's Journ. vol. x. p. 507.

its fore-part, near to the ribs, where these coats are connected by the ciliary ligament. The internal surface of this coat, after its vessels have been well filled, has a villous surface, like velvet. Ruysch has described this coat as double; but I doubt much whether it be so in the human body, unless we admit that the fine cellular substance, in which the dark-coloured paint is lodged, is a distinct coat. In the whale it is obviously so, and also in fishes. The inner layer of it has been called the *Tunica Ruysciana;* and it merits mention, that this layer may be separated from the outer part of the choroid coat in quadrupeds; and it is of finer and closer texture.

The brown colour of this coat is derived from the paint which covers its surface shining through it; and this paint, which is thicker in the fœtus than in the adult, and darker coloured in the Negro than in the European, is of a very peculiar nature.

In many of the inferior animals, a considerable portion of the choroid coat in the bottom of the eye has a metallic lustre, and has been called *Tapetum.* The tint varies in different animals. In the ox it is of a sea-green or leaden hue; in the horse of an azure blue; in the cat tribe yellow; in the lion like gold; and in the shark, like the amalgam on the back of mirrors.

Dr Drummond discovered a very singular property in this tapetum. When the choroid, and its tapetum, are dried upon a plate of glass, they become black; and, when again moistened by water, the brilliant colour returns. Dr Drummond observes, "I washed off the back silvery part of the choroid coat of the haddock, with a hair-pencil, and about half a tea-spoonful of water. The latter became of a milky colour, and on examining a drop of it, with an Ellis's aquatic microscope, I found the milkiness to be owing to innumerable slender, flat, silvery spicula, which had composed the substance of the choroid. They seemed to be in constant motion, apparently rolling upon their axis, but having no degree of progressive movement. The light reflected from their surface was very brilliant, like that from polished silver, and of-

ten disappeared and again returned, with alternations so rapid, as to produce a twinkling, very like that of a fixed star.

" Sometimes, on examining an individual specimen, it would disappear altogether, but in a few minutes return, renew its twinkling, and apparent revolution an its axis, and again disappear, to return as before *."

Of the Corpus ciliare.

Nearly opposite to the ciliary circle, there is a dark-brown radiated circle, about one-sixth of an inch broad, called *Corpus ciliare;* and, near to the connection of the corpus ciliare with the root of the iris, the choroid coat is folded into sixty or seventy folds, which are lined by dark paint.

The corpus ciliare is not a muscular organ, but consists chiefly of a very minute plexus of bloodvessels, the continuation of the ciliary artery.

The corpus ciliare is fixed to the retina at the fore-part of the vitreous humour, and, a little behind, to the edge of the crystalline lens.

The branches of the larger ciliary arteries, after having perforated the sclerotic coat, pass along the outer surface of this coat, and divide into branches at the ciliary circle; and, upon the surface of this coat, there are also veins which describe segments of a circle, and have been called therefore *Venæ verticosæ.*

The *nerves*, called *Ciliary*, which are flat, may be observed passing along the surface of this coat, accompanied by the long *ciliary arteries;* and the ramifications of the shorter ciliary arteries also perforate the sclerotic coat, near to the entrance of the optic nerve; run along a part of this coat, afterwards perforate it, and are distributed on its internal villous surface.

Of the Ciliary Ligament or Ciliary Circle.

The ciliary ligament is placed a little more than a line behind the cornea, and composed of dense cellular substance,

* Vide Trans. of the Royal Society of Edin. vol. vii. 377.

and appears as a grey-coloured ring. This ligament connects the choroid coat and margin of the iris to the sclerotic coat.

Dr KNOX has endeavoured to prove that the ciliary ligament is a distinct muscle. A triangular canal has been described by FONTANA, SŒMMERING, and MURRAY, as running along this ciliary ligament, and as being partly formed by the groove at the edges of the cornea and sclerotic coat.

The ciliary circle and roots of the ciliary processes are firmly glued to the anterior part of the retina, almost as far as to its termination or insertion in the outer edge of the lens.

Of the Ciliary Processes.

The ciliary processes are mere doublings of the choroid coat, the extremities of which hang loose in the aqueous humour, and are about sixty in number. The ciliary processes are chiefly composed of a plexus of vessels; they are not muscular, and there is no reason to suppose that they compress the lens. These processes have no direct connection with the lens. My Father has remarked: "ZINN, who observed that the terminations of the ciliary processes were not connected with the lens, concluded, therefore, that the inner parts of the ciliary processes were inserted into the capsule of the vitreous humour; but I have already observed, that the anterior part of the retina reaches to the edge of the lens, or intervenes between the ciliary processes and vitreous humours. It appears, therefore, that the ciliary processes do not form a complete septum between the aqueous and vitreous humours."

Of the Optic Nerves and Retina.

The optic nerves, to the naked eye, have externally less of a fibrous appearance, and are whiter, than the other nerves; but, when divided transversely, and examined by a magnifying glass, their component fasciculi become obvious: they are then seen to be composed of an opaque and transparent part, which latter is the gelatinous substance between the fasciculi. The optic nerves are covered by the dura and pia mater.

I met with a very striking proof of the intermixture of the

optic nerves in the case of a person who, for several years before his death, had lost the use of one of his eyes.

The optic nerve describes a tortuous course to the orbit, and is contracted where it enters the sclerotic coat, in which there are a number of small holes. The central artery runs in the axis of the optic nerve.

The optic nerve enters the eye-ball rather nearer to the nose than the axis of the eye-ball; and is expanded into a very delicate pulpy substance, which is nearly transparent in the eye immediately after death, called by anatomists *Retina*. The retina consists of a thin plane of medullary matter, which, during life is nearly transparent, but when put into spirits, becomes like ground glass: it extends as far forwards as the greater diameter of the capsule of the crystalline lens, between the choroid coat and capsule of the vitreous humour.

The retina is not of an uniform thickness; it is considerably thicker at its posterior than at its anterior part, and is in immediate contact with the choroid coat, but does not adhere to it by cellular substance, nor to the capsule of the vitreous humour.

The retina is very thin, especially under the ciliary processes, to which it is glued, and by which it is impressed, so as to have a striated appearance.

" The retina, at its connection with the vitreous humour and crystalline, is remarkably tougher than it is in any other part; or it seems to adhere there, to the anterior layer of the capsule of the vitreous humour, by cellular threads, or perhaps by the pia mater, which accompanies the nerves, in their whole progress.

" In consequence of the termination of the retina being extended to the crystalline lens, it is evident, that, in couching, the surgeon must, before he reaches the lens, wound the retina with his needle; and if he afterwards depresses the capsule, along with the body of the lens, or if a needle is passed around the lens, in order to detach it from the neighbouring parts, as has been advised *, the anterior edge of the retina must be lacerated, and very much injured.

* Mr du Wenzel *junior* on the Cataract, sect. xvi.

" As the rays of light cannot be directly collected, so as to form a distinct picture on that part of the retina which lines the ciliary circle and ciliary processes, there is perhaps reason to suspect, that the light which is reflected from the picture formed at the bottom of the eye, does not assist vision, by giving a second stroke to that part of the retina on which the distinct picture is formed,—which seems to be the idea of authors; for such a second and posterior stroke would have nearly, or exactly, the same effect as the first; but rather, that we receive, on the anterior part of the retina, lining the ciliary circle and roots of the ciliary processes, a second and very different kind of impulse, by the light reflected from the bottom of the eye to this part, by which we see and judge better of the object.

" This supposition seems to be strongly supported, by the general observation, that the paint lining the choroid coat, at the bottom of the eye, which has been called *Tapetum*, is remarkably bright, and fit for the reflection of light, in those animals which seek their food in the night-time, when such an aid is evidently most necessary."

On the sides of the optic nerves next the temple, and about two lines from the entrance of the optic nerve, there is a small aperture in the retina encircled by a yellow border.

This aperture was only of late discovered by Sœmmering, and probably because, if the eye be not very recent, it is often covered and concealed by a fold of the retina: no such folds exist in a very recent eye. This I ascertained in the eye of a person who was hanged, and which I examined within six hours after death.

Some anatomists have denied the existence of this foramen, and have affirmed that the appearance of a foramen is produced by a want of the medullary substance of that part of the retina. But if a very recent human eye be examined in the manner above described, I conceive there can be *no doubt as to the existence of a foramen.*

This aperture is best seen by looking through the vitreous humour, after having removed the cornea, iris, and crystalline lens: thus the parts of the eye are not confounded.

In children and old persons the border is not so apparent as in the adult; as, instead of being yellow, it is of a very light straw colour.

This foramen was for some time supposed to be proper only to Man, and the genus Simia. Dr Knox, however, discovered it also in lizards, as in the *Lacerta superciliosa*, *scutata*, *striata*, and *calotes*; but it is wanting in the lizards called *gecko*, and *mabuya*. In these animals, it is proportionally larger than in the human body, and is more evidently a foramen, for in the human body, it has been disputed whether it was a spot upon the retina or a foramen.

The retina is involved on its inner side, and also outwardly, by a membrane somewhat like to the pia mater, which separates the medullary mater from the choroid coat. The outer membrane was described by my Father as resembling the pia mater, and more lately it has been fully described in the Philosophical Transactions, by my former pupil Dr Jacob of Dublin.

The membranes which involve the retina pass nearly to the circumference of the crystalline lens, and, by passing over the canal of Petit, add considerably to its strength.

The central artery of the retina may be very distinctly seen, at the same time as the small hole in the retina, ramifying upon the surface of the retina; and sometimes we observe its branches encircling the small hole in the retina.

The axis of the eye-ball does not correspond with that of the orbit. The axis of the orbit is directed obliquely outwards, whereas the axis of the eye is directly forwards; and the axes of the two eyes are parallel.

That part of the optic nerve which enters the eye-ball is insensible. My Father has observed: "I found that the diameter of the object which disappears is very nearly equal to one-ninth part of our distance from it; or that, at the distance of nine feet from a wall, a circle one foot in diameter is lost. If, therefore, we suppose the human eye to be one inch or twelve lines in diameter, and that the rays of light issuing from the object, decussate about the centre of the crystalline lens, which is nearly three lines behind the cornea, or nine

lines from the retina; the insensible spot on the bottom of the eye will be one line in diameter; and, with this calculation, I found that the actual measurement of the medullary part of the optic nerve agrees very nearly.

" I next found, that an object begins to disappear when the point to which the eye is directed is one-fourth of the distance of the eye from it; and hence, upon the supposition above stated, the axis of the eye-ball will be found to be two lines and a quarter from the outer side of the optic nerve, and two lines and three quarters from its centre."

There are a number of small arteries distributed upon the surface of the retina, which are derived from the central artery of the optic nerve: these probably enable the nerve to communicate its impressions with greater force.

The retina is the seat of vision, and the whole of the retina (says Dr Young) is of such a form as to receive the most perfect image on every point of its surface that the state of each refracted ray will admit; and the varying density of the crystalline lens renders that state more capable of delineating such a picture than any other imaginable contrivance could have done.

Marriote and Priestly thought the choroid coat the seat of vision,—an opinion contrary to analogy, and disproved by the effect of pressure on the thalami inducing blindness, and by diseases which injure the optic nerve.

The insensibility is not owing to the central artery, for the size of the insensible spot is greater than the space occupied by that artery.

It has been supposed by Comparetti, that every part of the retina is not equally sensible to the impressions of light: he states, that distinct vision only takes place in the optic axis.

Upon this assertion Dr Young has justly remarked, speaking of his own eye, that the visual axis being fixed in any direction, he can see at the same time a luminous object placed at considerable distances from it The angle, however, differs: upwards it extends to 50°, inwards to 50°, downwards to 70°, and outwards to 90°.

In short, the internal limits of the field of view nearly correspond with the external limits formed by the different parts of the face, when the eye is directed forwards and downwards, which is its most natural position.

Further, Mr HALDAT's observations, made by producing an artificial strabismus, shew, that COMPARETTI's opinion may be contradicted by actual experiment: for in the case of squinting occasioned artificially, one of the impressions falling on a part beyond the visual axis should not produce a perception of the object, which it is known is not the case.

An imperfect degree of sight or complete loss of the sense is one of the more common infirmities of old age. To this malady, called *amaurosis*, hard students, engravers, watchmakers, and other mechanics, whose business requires an examination of very minute objects, and the frequent use of magnifying glasses, are peculiarly liable.

The disease is not limited to the decline of life only; an organic disorder of the optic nerves, an attack of apoplexy, palsy, hydrocephalus, a severe blow upon the head, the use of narcotics, or even the exposure to the fumes of different poisons, or a disordered state of the bloodvessels, will at any period of life suddenly destroy the sight to a greater or less degree. There are various degrees of depravation of sight; there are some, who see only small black spots upon a sheet of white paper held before the eyes; and I shall never forget being consulted by a gentleman profoundly skilled in mathematics, who used to amuse himself, by endeavouring to ascertain the precise seats of the insensible portions of his retina. There are others who cannot see objects above the level of the eye; and there are others who retain the use of their eyes, so far as to be able to walk about, but who cannot read a book.

There are some persons who are afflicted by an occasional loss of sight. This probably depends on the morbid state of the functions of the stomach or bloodvessels; as it may be removed by purging and the lancet. A partial loss of sight is not unfrequent amongst fat horses that have been turned out to graze, and the blindness originating from such a cause is soon carried off by the purgative effect of the green food.

I was lately consulted by a young lady who has suffered several attacks of periodical blindness, which she and her relatives imputed to the sting of a wasp on the upper eye-lid. When stung she suffered very acute pain in the eye-ball, which was speedily succeeded by inflammation, and swelling of the eye-lids and face. By the application of several leeches, blisters applied behind the ear, and the operation of aperient medicines, the inflammation and swelling were speedily removed; but, upon opening the eye-lids, she was much mortified to find she had lost the sight of the eye, and did not recover it. My advice was therefore required. Upon my first visit, I could perceive (as happens in other instances of amaurosis) nothing unusual in the appearance of the eye, excepting an enlargement and immobility of the pupil. She could distinguish day from night, but nothing more. Her eye was tolerably easy; she had slight pain in the forehead; and her pulse was between 80 and 90 in the minute; in other respects her health was not impaired. It was recommended to again try the effect of the application of a number of leeches to the temples, of purgatives, and of blisters behind the ear. These proving of no avail, a slight and long protracted course of mercury was prescribed.

After she had used the remedy for two months, her general health became so much impaired, that the mercury was therefore given up.

Two months more had scarcely elapsed, when she was seized suddenly during the night with a sense of working (as she called it) and of pain in the eye-ball; and next morning, to her great delight, found she had regained her sight, and told her parents that she saw as well as ever with her bad eye. She continued to have the full use of her eye for the next four months, after which she again became blind for six weeks, without any obvious cause. She took a little more mercury, and again regained her sight; and what is remarkable, she has lost and regained her sight, five or six different times during four years; but unfortunately, at the time these sheets are at press, she has completely lost the use of her eye.

Since my attention was directed to this young lady's case, I have heard of three others of a similar description.

I have stated, that the pupil is generally much expanded, and at the same time immoveable, when the retina has lost its sensibility. But this general remark is liable to some exceptions. The pupil is sometimes much contracted, which is the most alarming state, as it is beyond all cure, and often connected with an adhesion between the iris and capsule of the crystalline lens. There is still another state of the pupil, which had in a peculiar manner attracted the notice of my Father. In this instance, the enlarged pupil becomes still farther expanded, upon exposure to a vivid light, owing to the person making, as it were by instinct, an attempt to see.

It may be added, that a few hours before death from hydrocephalus, the pupil, which had been much expanded, becomes in some instances very considerably contracted.

When amaurosis has been of long continuance, there is a shrinking of the thalami nervorum opticorum, and of the optic nerve, and also of the muscles of the eye-ball *.

Dr Wollaston, from having noticed that he occasionally lost the sight of half a word, has supposed that there is a semidecussation of the fibres of the optic nerves †.

Of the Iris or Moveable Curtain.

The iris floats in the aqueous humour; is of different colours in its fore-part in different individuals, corresponding with the colour of the hair; being light-blue or grey when the hair is light, and brown or black when the hair is black.

There are some exceptions to the above. Sometimes the iris is dark, when the skin is white, and such persons have commonly dark eye-lashes. Sometimes the irides of both eyes are not exactly of the same colour.

I have seen portions of the same iris of different colours. Sometimes the upper part is of a light brown colour, and the lower half of a light blue.

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* See what has been above stated in this Work, p. 320. of this Volume.

† Phil. Trans. for 1824, Part 1st.

In some animals, we frequently observe a difference of colour in different parts of the same eye.

The iris of the albino is generally of a pale red or purple hue.

The iris or moveable curtain is placed behind the cornea, and is calculated to prevent too much light from reaching the bottom of the eye.

The iris of the Negro is black, and not readily distinguished from the pupil. When the iris is in a state of inflammation it loses its natural brilliancy, and has a puckered appearance.

According to the late Mr Saunders, the inflammation of the iris is accompanied by diffused vascularity of the tunica conjunctiva, and the fine vessels of the iris are injected with blood. When the disease has made further progress, the edge of the pupil is thickened, it is immovable, and it has not its circular appearance.

In the centre of the iris there is an aperture called the *pupil*; the size of which varies according to the degree of light to which the eye is exposed.

The iris prevents those rays of light from entering the eye, which do not enter it nearly in the direction of its axis.

On the posterior part of the iris, there is a dark-coloured mucous matter, which may be readily washed off, and which was called by the older authors *uvea*, from its supposed resemblance to a black grape in colour.

Dr Jacob describes a transparent membrane, which is closely attached to the margin of the pupil, from whence it is continued over the back of the iris, and anterior extremities of the ciliary process, to the circumference of the lens. This membrane may be turned down by the point of a needle, as it is loosely connected with the iris, in the interstices of which the black paint is deposited.

When the paint has been washed off, two sets of fibres come into view: one set is concentric around the pupil; the other set issues from the pupil, as from a centre, to the circumference of the iris.

The iris, according to my Father, is a muscular organ.

" Its appearance is, in all respects, so evidently muscular, that I think there can be no doubt of its being the sphincter of the pupil: And I can only account for its having escaped the observation of Dr Haller and Dr Wrisberg, by supposing that they had not washed off the black paint, which covers and conceals it, as well as the red vessels of the iris."

In the human body, fibres are seen around the pupil on its fore and also on its back part, and the space between these fibres and root of the iris is filled up with vessels and radiated fibres. These fibres are not equally apparent in all instances, and they are much more distinct in the leopard than in any other animal I have examined.

The iris was supposed to contract merely by its elasticity, but this opinion cannot be admitted.

As a proof of muscular power, observe that, in the moribund, the pupil attains an extrordinary size, but immediately after death it contracts, which could not be owing to mere elasticity.

Farther, in hydrocephalic children, the pupil, owing to its insensible state, is dilated, when a candle is applied to the eye.

Dr Brewster has concluded *, that the " power of adjusting the eye depends *on the mechanism which contracts and dilates the pupil*, and since this adjustment is independent of the variation of its aperture, it must be effected by the parts which are in immediate contact with the base of the iris."

The iris divides the aqueous humour into two chambers, an anterior and posterior: the anterior is placed between the posterior surface of the cornea and the anterior part of the iris.

The posterior chamber is situated between the posterior surface of the iris, and the anterior part of the crystalline lens.

The iris receives its blood by the long ciliary arteries. These arteries converge towards the pupil, and when they approach it, they separate, and form portions of circles around the pupil.

* Edinburgh Journal of Science, vol. i. p. 81.

The long ciliary arteries which supply the opposite sides of the iris freely anastomose with each other; and the smaller vessels of the iris form a circle around the pupil.

The iris is supplied with nerves by the branches of the ciliary nerves; and these are larger and numerous in proportion to the bulk of the organ.

The motions of the iris are involuntary, and depend on the quality of light which falls on the retina; for light falling on the iris itself does not occasion the contraction of the pupil; hence, when the retina loses its sensibility, the iris does not move, but remains much dilated. Upon examining a minute object, the pupil is contracted, to exclude the most divergent rays of light, which could not be united on the retina. But in some animals, as the parrot, the movements of the iris are voluntary.

In the fœtus in utero, about the sixth month, the pupil is closed by a very thin membrane, called therefore *membrana pupillaris*, and after the vessels of the iris have been successfully filled, vessels may be seen passing to the very centre of the membrane of the pupil.

In the centre of the membrana pupillaris, there is a transparent portion.

This membrane gradually disappears, so that when the child is born there is generally no vestige of it. In one instance, I had occasion to see a part of it in a healthy child of ten months old: it appeared like a greyish film.

Of the Aqueous Humour.

The aqueous humour is contained within the two different chambers: the anterior or larger is placed between the cornea and iris; and the posterior between the iris and crystalline lens.

By this humour the cornea is distended, so as to assist in collecting the rays of light.

The aqueous humour also serves as a defence to the iris and crystalline lens.

This humour in the adult is remarkably pellucid, in order that the light may readily be transmitted through it, but in

the fœtus frequently turbid; and, according to Chenevix, it consists of jelly, albumen, water, and muriate of soda.

Different opinions have been entertained respecting the source of this humour.

Zinn has stated, that this humour is secreted by the capillary vessels of the iris.

This humour is very quickly regenerated.

As the aqueous humour is nearly of the same density as water, therefore it cannot refract the rays of light; consequently it could be of no use to fishes, and in them it is awanting; but as, when birds soar to the higher regions of the atmosphere, the air is much rarified, the refrangibility of the aqueous humour is more considerable; and hence, in birds, there is a considerable quantity of this humour of the eye.

The aqueous humour is said to be contained in a membrane which is continued over the iris, and gives to that membrane its elasticity, which is so very remarkable in birds.

Des-Mours has described the membrane that contains the aqueous humour as being of a cartilaginous nature,—an opinion which has also been adopted by Dr Jacob *, who supposes, that thus the cornea "preserves correctly the regular degree of curvature."

This membrane may be demonstrated readily, after an eye has been, for a few days, in water, or after separating the cornea, if it be put into boiling water.

Of the Crystalline Lens.

This humour has been called *Crystalline Lens*, being like transparent crystal, and in its form like a double convex lens. It is placed in the middle axis of the eye, behind the pupil.

The anterior surface is opposed to the back of the iris, and its posterior part is imbedded in the vitreous humour.

The human crystalline lens varies in colour and figure at different periods of life: in the fœtus it is reddish, but soon after birth becomes transparent, and nearly spherical; in middle life it is transparent, and in figure like a double convex lens,

* Medico-Chir. Trans. of London, vol. xii. part ii. p. 503.

which is more convex behind than before; but in old age it frequently acquires a greater firmness, and a topaz colour.

According to ZINN, the lens, at the twenty-fifth or thirtieth year, acquires a degree of yellowness, which gradually increases as age advances; so that, at length, it becomes like a piece of amber. This yellowness, he adds, he has often observed to begin in the centre of the lens.

ZINN has also remarked, p. 130, that it often happens that there is no difference as to the colour, firmness, or convexity, of the eyes of the old and young.

PETIT has been at great pains in measuring the convexity of the anterior and posterior part of the lens.

My Father * has remarked upon these measurements:—

"PETIT has stated, that the radii of the anterior part of the lens may be the same in two different lenses, but the radii of the posterior are different, and yet the breadth and thickness the same; but if the posterior radius be longer, the lens must be flatter and thinner; and if shorter, the lens must be more convex and thicker."

The lens is found to be composed of albumen, jelly, and a little water.

It has been a matter of doubt, whether or not it be possible to trace any bloodvessels into the substance of the crystalline lens.

I have injected a branch of the central artery of the retina, which passed through the vitreous humour: when it reached the back part of the capsule of the lens, it sent a number of small branches to the circumference of the lens; but I never could distinctly trace any one branch of that artery into the substance of the lens.

It is not possible to detect the nerves of the lens.

The crystalline lens is a soft tender substance, of unequal density: in the centre it is firmer, tougher and heavier, than in its circumference; and hence possesses a more equal refractive power than any artificial lens.

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* Vide his Book on Fishes.

It may be asked, Why is not the lens of an uniform density? This question it may be difficult to solve. Mr Ramsden supposes that it tends to correct the aberration occasioned by the spherical form of the cornea, where he supposes the principal refraction takes place. Owing to the particular structure of the lens, he supposes that it refracts without reflecting any of the rays of light, so that, though there are two surfaces of the aqueous, of the crystalline lens, and of the vitreous humour, yet there is only one reflected image; and that being on the front of the cornea, there is no surface to reflect it back, and to render the image, upon the retina, less distinct.

If the surfaces of the crystalline lens had been abrupt, there must have been a reflection at each.

As the centre of the lens is much more dense than the circumference of it, thus the aberration, occasioned by the spherical surface of the cornea, is corrected, and the focus of each oblique pencil of rays falls accurately on the concave surface of the retina.

The particular structure of the lens is subservient to another purpose.

The image of the object which strikes the retina, is free from any prismatic colours, occasioned by the different refrangibility of the rays of light; which would have rendered the picture confused.

The capsule adheres but slightly to the body of the lens; a small quantity of water being said, by most authors, to be interposed.

The lens may be readily detached by slight pressure, after puncturing the capsule.

The anterior portion of the capsule is not only very pellucid, but also very elastic; but the back part of it is much softer and thinner.

I never could find any liquor between the posterior part of the lens and its capsule.

My assistant Mr Mackenzie informs me, that he cannot find any of the liquor Morgagni in the eye of the ox, sheep

or dog, if the eye be examined immediately after the animal is killed.

Much pains has been taken to discover the intimate structure of the crystalline lens.

If the lens be dried, it is then composed of a number of layers, which may be readily separated from each other.

These layers are made up of fine fibres, like those of spun glass, which describe a different course, in different parts of the human lens, and a different course in the lenses of different animals.

Leeuwenhœck has published a figure representing the course of these fibres; and also Dr Young, who has endeavoured to prove these fibres muscular, and also that the eye accommodates itself to distant objects, by the increase of the convexity which that muscularity produces. Upon this opinion, Dr Brewster has most justly remarked, "When we consider that the fibres are lines of contrary flexure, we venture to say, that no sagacity is capable of predicting the actual effect which would arise from their contraction. One thing only is certain, that the fibres of the outer laminæ would, in the process of contraction, press upon those of the inner laminæ, and destroy that compound gradation of density by which the aberration of sphericity is so finely corrected *."

It has been supposed that, by means of a very small muscle which Sir Everard Home affirms he discovered, the eye is adapted to objects of different distances. He says,

"Having discovered a muscle arising from the capsule of the vitreous humour, and inserted into the capsule of the lens, whose fibres are $\frac{25}{1000}$ of an inch long, and knowing, from other observations, that muscular fibres can contract to one-half of their length, *I cannot doubt of the lens being moved through that space by this muscle;* and, when Mr Dollond, who is more competent than most other men, by his knowledge of optical instruments, to give an opinion on the subject, assures me that, according to his judgment, such a change of place in the lens is sufficient to account for the ad-

* Edinburgh Journal of Science, vol. i. p. 78.

justment of the eye, it is impossible for me to doubt of its being done in this way, in the absence of all other means for that purpose.

"It is no small corroboration of this being the use of the muscle, that there is a similar muscle employed to tune the ear, by tightening the drum.

"It is now ascertained that, when the crystalline lens is removed, there *is no longer a power of adjusting the eye;* but so great is the compensation produced, by diminishing the size of the aperture, that both Mr RAMSDEN and myself were deceived, and believed that such power still existed, till experiments with Dr YOUNG's *Optometer* exposed the error.

"An experiment made with the *Belladonna*, upon the eye of a gentleman sixty-nine years of age, who had been myopic from his earliest infancy, proved, that although the influence of the belladonna increases the size of the pupil beyond that of the other eye, the adjustment remains the same,—*the muscle of the lens in myopic eyes of long standing losing in degree the power of contraction, probably from want of size*†."

An opacity at the pupil was formerly called by authors a *Cataract.*

Membranes growing upon the iris sometimes cover a part or the whole of the pupil. These are commonly white and opaque, resembling the membranes or specks which we often observe covering part of the cornea.

In two cases, my Father observed filaments passing along the pupil, of the same colour as the iris, in which they were rooted. These were not perceived by the patient, just as threads glued to the surface of a convex lens or magnifying glass do not appear in the focus of the rays which it collects, or in the pictures which it forms of objects.

By the term *Cataract* is now-a-days understood *an opacity of the capsule, or substance of the crystalline lens.* The former may be called the *Membranous*, and the latter the *Crystalline*, cataract.

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† Vide Sir E. HOME's Lect. on Compar. Anat. vol. iii. p. 213.

The celebrated KEPLER, who lived in 1604, was the first who demonstrated the true use of the crystalline lens; and BORELLI, BONNET, and GASSENDI hence concluded, that cataract was a disease of the lens.

The opacity of the substance, or body of the lens, is much more frequent than that of its capsule; for the pupil generally is clear, after the extraction of the body of the lens.

In the membranous cataract, the fore-part of the capsule is more frequently opaque than its back part.

The centre of the lens generally becomes first opaque, and assumes a yellowish-brown colour; and the size of the lens is somewhat increased; sometimes the cataract is very white, soft, and larger than the lens in a sound state, especially when the disease appears at the period of birth.

Cataracts differ as to size, colour and firmness; hence they have been divided into the hard, fluid, and caseous.

The *hard dark coloured cataract* is the smallest; and a considerable space intervenes between the cataract and pupil; whereas *the white and softer, or fluid cataract*, which appears at the period of birth, is of a much larger size, and protrudes a little through the pupil.

The *caseous cataract* holds a middle state, as to consistence and size, between the hardest and softest cataracts. This kind of cataract very much resembles, in miniature, those white clouds which appear in a sunny day; that is, there are irregular grey-coloured spots upon a whiter ground.

In a few instances, the cataract is not of an uniform consistence in every part; being softer externally than internally.

After the body of the lens has been extracted, an opacity often forms in the capsule of the lens which is left. As the opaque cataract occasions, to a greater or less extent, a loss of sight, and as the disease is seldom or never removed by medicines given internally, or by external applications, it is necessary to have recourse to the aid of the surgeon.

Cataracts may be extracted by making a semicircular cut through the lower part of the cornea, and then by puncturing the capsule of the lens with a fine needle, and afterwards

by pressing out the diseased lens; or it may be depressed by pushing the diseased crystalline lens out of the axis of vision, or by displacing, by means of a needle, and bringing it through the pupil into the aqueous humour, in which it is dissolved.

There are no vessels or nerves either upon the capsule or body of the lens in the adult, of such a size as to admit the red globules of the blood; but, in the fœtus, there are a number of small branches of the central artery of the retina, which are distributed upon the back part of the capsule of the lens.

Of the Vitreous Humour.

This transparent humour, which, in colour and consistence, bears a strong resemblance to the glaire of an egg, is contained in a very thin capsule, named *Tunica hyaloidea.*

Besides the general capsule, there are septula passing across the vitreous humour, which communicate with each other; so that an hour at least elapses before the whole of the vitreous humour is discharged, though a considerable aperture be made in the capsule.

According to Mr Chenevix, this humour consists of water, albumen, jelly, and muriate of soda, and its specific gravity is 1.0053.

This humour occupies the greater share of the ball of the eye, and keeps the retina at a proper distance from the bottom of the eye: it gives ready passage to the rays of light as they are converging into foci upon the retina; and it may also tend to preserve the retina of a spherical form.

The capsule of the vitreous humour, according to my Father, divides at the forepart into two layers. "Within the roots of the ciliary processes, it adheres closely to the retina; and, a little farther forwards, it seems to divide into two distinct layers. The external continues to be glued to the retina, and accompanies it to its termination, which we shall find to be in the forepart of the capsule of the crystalline lens, about one-twentieth of an inch from its outer edge: The internal layer adheres firmly to the vitreous humour, till this is connected with the

posterior part of the capsule of the lens, at the like distance, nearly of one-twentieth of an inch from its outer edge; and, at the distance, therefore, of one-tenth of an inch from the connection of its anterior layer and retina with the lens. The outer edge, therefore, of the crystalline lens, covered with its proper capsule only, occupies a space nearly one-tenth of an inch in breadth, between the two layers of the capsule of the vitreous humour.

"The anterior layer of the capsule of the vitreous humour being fixed to the crystalline lens, at the distance nearly of one-tenth of an inch from the attachment of its posterior layer, —a canal, bounded by the two layers of the vitreous humour, and by the edge of the crystalline lens, as its basis, is formed, which was discovered by Dr PETIT, and is named after him *. Air, blown into this space, passes, of course, around the crystalline lens. Each of the two layers of the capsule of the vitreous humour is tougher than the posterior part of the capsule, and adheres firmly to the capsule of the lens."

Sir E. HOME mentions, that "he had observed, in the eye of bullocks, a semitransparent tube, resembling the coats of a lymphatic vessel, which terminated in the vitreous humour."

I have remarked, more than twelve years ago, in a case of fungus hæmatodes of the eye, several small tumours, very like to enlarged lymphatic glands, situated along the optic nerve; and though there is no such tube as that noticed by Sir E. visible in the human eye, the above fact seems to me to confirm the opinion of Sir EVERARD as to the nature of the vessel he had observed in the eye of the ox, and through which the poison had passed, which had created the swelling of the lymphatic glands of the orbit.

Muscles of the Eye-Ball.

There are six muscles which move the eye-ball; five of which take their origin from the sides of the foramen opti-

* Vide Mem. de l'Acad. des Sciences, 1726.

cum, and have been named from their direction, or apparent action. The *sixth muscle*, the inferior oblique, takes its rise from the fore-part of the orbit.

These muscles have been called *straight* and *oblique muscles*, but are not exactly so, on account of the shape of the orbit.

The above muscles terminate in broad thin tendons, which are inserted into the sclerotic coat under the tunica adnata, about one-sixth of an inch from the cornea.

By the straight muscles, the axis of the eye is directed towards different points; and by their combined action, the eye-ball is directed towards any intermediate point, or in a circle by the successive action of these muscles.

Rectus Superior, or *Levator Oculi.*

This muscle passes, nearly horizontally, below the levator palpebræ superioris and optic nerve: it is the thinnest of the recti muscles; takes its rise from the upper part of the foramen opticum, and is fixed into the sclerotic coat, about one-fifth of an inch from the edge of the cornea.

By this muscle the eye-ball is raised.

Rectus Inferior, or *Depressor Oculi.*

This muscle is situated in the lower part of the orbit; takes its rise from the lower part of the foramen opticum, and is fixed opposite to the insertion of the former muscle, into the sclerotic coat.

By the above muscle, the fore-part of the eye-ball is depressed.

Abductor and Adductor Oculi.

The eye-ball is provided with an ABDUCTOR and ADDUCTOR muscle; the former of which arises from the inferior and posterior part of the fissure of the orbit, and is fixed into the eye-ball opposite to its outer angle; the latter, the shortest, thickest and straitest of the recti muscles, arises from the side of the foramen opticum, and is inserted opposite to the inner angle of the eye.

By the *abductor*, the eye-ball is pulled towards the temple; by the *adductor*, towards the nose.

Obliquus, Superior and Inferior.

The former arises from the side of the foramen opticum; its tendon included within a bursa, passes through a cartilaginous pully, fixed behind the internal angular process of the os frontis; it afterwards is reflected under the levator oculi, and is fixed into the sclerotic coat, between the insertion of the levator oculi, and entrance of the optic nerve. The latter arises from the anterior edge of the orbitar process of the superior maxillary bone, and is inserted into the sclerotic coat, between the entrance of the optic nerve, and the insertion of the abductor oculi.

By the superior oblique, the pupil is turned downwards and outwards; and by the inferior, upwards and inwards.

The oblique muscles of the eye form a girth around the eye-ball, between the lens and the bottom of the eye: hence, by their pressure, they increase the distance of the lens from the retina, or increase the posterior part of the axis of the eye-ball.

There are various instances of the irregular action of the muscles of the eye-ball: these very often occur in epilepsy, hysteria, and other diseases called nervous.

Many persons do not direct the axes of both eyes towards the same object, which is the cause of squinting, and is owing to the irregular action of the muscles of the eye-ball. It would appear, that some time elapses before the muscles of the eye-ball acquire the power of acting in a correct manner, for the eyes of children at birth are moved in an irregular manner, and sometimes they squint, which generally goes off in a short time; for, by habit, we acquire an equal command over the muscles of both eyes, and direct the eyes as we please.

Squinting is also sometimes instantaneous, as when persons from any cause are thrown into a state of ecstasy.

A person who squints uses only one of his eyes at the same time, and in those who have long had this bad habit, the eye not used becomes imperfect. The muscles of the eye lose the power of giving the eye a proper direction: there is a want of correspondence between the actions of the muscles of both eyes; and according to the degree of imperfection in the action of the muscles of the eye, there is a greater or less degree of squinting. There are also instances in which persons squint only when looking at near objects.

It may be added, that squinting is sometimes occasioned by using one eye much more than the other. Thus those who use the telescope much, often squint; they use one eye very much, but not the other, the muscles of which lose their corresponding action.

From what has been stated, it is obvious, that squinting, proceeding from certain causes, may be removed by the use of a paper cover, blackened on the inner side, by which the person is compelled to use his eye, and to direct it properly, if the remedy be employed in due season, and for a sufficient length time, so that the muscles shall regain their proper mode of action; but if squinting be owing to absolute imperfection of the eye, there is no chance of removing it.

The fat which is lodged within the orbit, is of a very particular description: it is much finer than that of the other parts of the body; it serves as a defence and cushion to the several parts of the eye contained within the orbit.

The quantity of fat in the orbits is various. If accumulated in an unusual quantity, it renders the eye-ball very prominent; but if, on the other hand, it be in part removed, as happens in many diseases, the eye sinks within the orbit. There are other causes which occasion the displacement of the eye, as tumours in the orbit, exostoses, and the enlargement of the superior maxillary and frontal sinuses.

OF THE NERVES OF THE EYE-BALL, AND ITS APPENDAGES.

Besides the optic nerve which has been above described, the eye-ball, and its muscles, are supplied by the third,

fourth, and first portion of the fifth pair of nerves, and also by the sixth pair; and the eye-lids receive branches from the portio dura of the seventh pair.

The *second or optic nerves* have been above described.

The *third pair* is said to arise from the under and back part of the crura cerebri. The small threads connected with the crus cerebri, are inclosed in the pia mater, and when united form a nerve of a rounded form.

These nerves pass obliquely outwards and forwards, and run along the upper part of the cavernous sinuses; pass through the foramina lacera, and give branches to all the muscles of the eyes, excepting the superior oblique and adductor muscles, and send a branch to the ophthalmic ganglion.

The upper and smaller branches pass over the optic, and are spent upon the rectus superior muscle, and the attollens palpebram superiorem; and the inferior or larger passes under the optic nerve, and divides it into branches which supply the adductor muscle, and the rectus inferior, and inferior oblique muscle.

The *fourth pair of nerves* take their rise, by two or three small filaments, which are very soft, from the crura of the cerebellum, and medullary expansion, which lies over the passage into the fourth ventricle.

Each of the nerves of this pair is about the size of a common sewing thread: it winds round the crus cerebri, between the brain and cerebellum, and perforates the dura mater at the edge of the tentorium cerebello-superextensum; passes along the sinus cavernosus, crosses over the third pair of nerves, and then passes through the foramen lacerum; and, without giving off any branches, ultimately dips into the substance of the superior oblique muscle.

The Fifth, Trifacial or Par Trigeminum.

The *fifth* is the largest pair of nerves which is connected with the brain: it arises by an anterior portion from the sides of the crura cerebelli, where they are about to form the pons Varolii, and by a posterior part from the side of the pons, where the crura cerebelli join it.

The fifth pair, near to its connection, with the parts above named, sometimes consists of a single cord, or sometimes of several fasciculi, which are collected into a single nerve, and covered by the arachnoid coat, towards the upper angle of the pars petrosa of the temporal bone, a little below the tentorium cerebello-superextensum.

The nerve then swells out into a *plexus of a semilunar shape*, which is placed close by the outer side of the sinus cavernosus, in a doubling of the dura mater.

This plexus has sometimes been called GASSERIAN GANGLION, and consists of fifty fasciculi.

According to MECKEL and NEUBAUER, it consists of between forty-two and sixty fasciculi, and some authors have enumerated a greater number. I have called the swelling a *plexus* rather than a ganglion, the name applied to it by a number of anatomists, as it is more like to a plexus than a ganglion, to which it bears no resemblance in figure or structure.

VIEUSSENS and WINSLOW have described nerves as passing from the plexus into the dura mater, but MECKEL, who examined this point with great attention, has denied the existence of such nerves.

There are three large nerves derived from this plexus; first, the uppermost or anterior is the OPHTHALMIC: the second, which is about three lines broad, has been called the SUPERIOR MAXILLARY, as its branches are distributed chiefly upon the upper jaw; the third, which is the largest and lowest branch, has been called the INFERIOR MAXILLARY, as it supplies the under jaw, teeth and muscles fixed into the under jaw.

The first, or ophthalmic branch, passes forwards and upwards, in the vicinity of the sixth pair, within the cavernous sinus, and also near to the fourth pair, from which it is separated only by a thin lamina of dura mater: it then passes through the foramen lacerum of the sphenoid bone. This nerve then divides into three branches, called the Frontal, Nasal, and Lacrymal.

The frontal, or the largest branch, is the continuation of the

trunk of the nerve: it is placed immediately under the periosteum that lines the upper part of the orbit.

The nerve divides into three branches, which pass through separate foramina of the os frontis. The largest branch comes out at the foramen supra-orbitarium, or foramina supra-orbitaria; or it is lodged in a groove of the bone, and fixed down in that situation by a ligamentous membrane: it then divides into exterior and interior branches.

The exterior passes under the frontal muscle, and a number of the branches pass over the muscle, and supply the upper eye-lid, the corrugator supercilii, and fore-part of the occipito-frontalis muscle, and are continued to the back of the head, but they do not inosculate with the branches of the occipital nerve.

The interior branch supplies the corrugator supercilii, and it communicates with the supra-trochlear nerve.

The second branch, called *Supra-Trochlear*, or lesser frontal, passes under the superciliary ridge to the upper eye-lid and forehead.

The third branch, called *Infra-Trochlear*, is the smallest; this communicates with the supra-trochlear nerve, and distributes its branches at the side of the nose.

The *Nasal branch* is deeper than the other branches of the ophthalmic; it passes obliquely over the optic nerve; it sends off a small nerve, which passes to the outer side of the optic nerve. The trunk of the nerve then passes beneath the levator palpebræ superioris and levator oculi, and between the abductor oculi and superior oblique muscles, and gets within the cranium, through the foramen orbitarium anterius: it lies upon the cribriform plate of the ethmoid bone, and passes downwards through the foramina in the anterior part of this plate; it detaches small branches to the upper turbinated bone; and, according to Meckel, it frequently gives a branch to the frontal sinus.

The principal part of this nerve passes along the membrane at the anterior part of the partition of the nose, and it is ultimately spent upon the extremity of the nose.

Of the Ophthalmic, or Lenticular Ganglion.

Zinn has thus accurately described this ganglion *. "Ganglion ergo illud omnium ferè in corpore humano minimum, rubellum, ferè quadratum longius tamen quám latius, utroque latere compressum, ab interna parte qua nervum opticum spectat planiusculum, ab externa conversum, adsidet externo latere nervi optici aliquot lineas ab ejus ingressu, cui nervo multa cellulosa jungitur, et pinguedine multo fluidiori involutum, sub communi origine musculi attollentis, et capitis minoris musculi abducentis illique subjecto adipe ita latet, ut nisi musculo abducente prope ortum discisso, rite observari non possit."

The ciliary nerves, which are ten or twelve in number, are derived from the ophthalmic ganglion. These are very small, not larger than the hairs of the head. These nerves accompany the optic nerve, and enter the posterior part of the eye-ball obliquely, through the sclerotic coat. When they lie between the sclerotic coats they are flat. At the ciliary circle each nerve is subdivided into two branches, and at the root of the iris, these are subdivided into still smaller branches, which follow a radiated course; and near to the pupil they are united and form arches, from which very minute filaments pass to the margin of the iris.

Mr Charles Bell has made † a number of very ingenious observations on the actions of the muscles of the eye, which are highly worthy of the attention of the reader; and also upon the nerves of the orbit ‡.

According to Mr Bell,

"The third nerve goes to the muscles of the eye; it is a voluntary nerve, by which the eye is directed to objects.

"The fourth nerve performs the insensible traversing motions of the eye-ball. It combines the motions of the eye-

* De Oculo, page 204. † Vide Phil. Trans. for 1823, Part i. p. 176, &c.
‡ Vide idem, Part ii. p. 294. &c.

ball and eye-lids, and connects the eye with the respiratory system.

" The fifth is the universal nerve of sensation to the head and face, to the skin, to the surfaces of the eye, the cavities of the nose, the mouth, and tongue.

" The sixth nerve is a muscular and voluntary nerve of the eye."

OF THE APPENDAGES TO THE EYE.

Of the Eye-Lids.

The *Eye-lids* are moveable curtains, which cover part of the fore-part of the eye-ball, protect it from external injury, and from too vivid light, and keep the surface of the eye-ball always moist.

The eye-lids are connected with the orbits by condensed cellular substance.

The eye-lids are convex outwardly; concave inwardly when they are applied to the eye-balls; and the upper eye-lid is the larger and more moveable, and covers the greater part of the eye.

The skin lines the eye-lids: at the edges of these it becomes much thinner, and is continued after lining the back-parts of the eye-lids, upon the cornea, and a portion of the sclerotic coat forming the tunica adnata at the internal angle of the eye; the tunica adnata forms a fold somewhat like the third eye-lid of birds.

The *tunica adnata* has been described as a mucous membrane, but it has not the villous surface of the other mucous membranes, and, as a proof that the cuticle covers the cornea, hairs sometimes grow from it, as I have seen in the human body, and also in the ox; and in the class Amphibia, that change their cuticle at certain seasons, *the tunica adnata comes off with the rest of the cuticle.*

When the eye-lids are opened, there is always a wrinkle in the skin in each eye-lid, which is most obvious in the upper,

in consequence of the eye-lid being drawn under the edge of the orbit, by the attollens palpebram superiorem.

When the eye-lids cover the eye-ball the wrinkles totally disappear.

The eye-lids, or palpebræ, are of unequal size, the upper being the larger, and the more moveable.

The eye-lids are attached to the anterior edge of the orbit, by a condensed cellular substance, which has been by some authors described *as the ligaments of the eye-lids*.

The eye-lids are composed of thin skin, and a portion of the orbicularis muscle, and of the tarsal cartilages situated at the edges of the eye-lids.

The cellular substance of the eye-lids is remarkably fine, and is kept moist by a serous fluid, which in some cases is accumulated in considerable quantity, and which gives the eye-lids a bluish tint.

The internal surfaces of the eye-lids are quite smooth, and continually lubricated by a mucous fluid, which is derived from sebaceous glands.

On the anterior edges of the tarsal cartilages the hairs called *Eye-lashes* are placed.

The eye-lids are united at each end, and are said by anatomists to form the angles, or canthi; the internal is rounded, but the external is acute.

On the edge of each of the eye-lids, there is a thin plate of cartilage, which describes an arch; and this cartilage is thicker and broader in its middle than at either extremity, at what have been called the external and internal angles.

The *Tarsal Cartilages* are thin and flexible, and keep the eye-lids always extended and accommodated to the form of the eye-ball.

The posterior edges of the tarsal cartilages are so shaped, as to form a triangular groove for the tears, when the eye-lids are shut; and as the outer angle of the eye-lids is higher than the inner, the tears are directed towards the puncta lacrymalia; the mouths of which are placed at the inner angle.

When the upper eye-lid has been raised, the tarsal cartilage keeps the eye-lid extended and smooth.

The eyelids are not so thick and opake as entirely to exclude light, but very effectually defend the eye against too vivid light. They also defend the eye from the particles of dust floating in the air, and from external injury; and, by their movements, probably occasion an increased secretion of tears. These have also an effect in determining the flow of tears towards the puncta lacrymalia.

Of the Ciliary Glands.

The ciliary glands, which are composed of a number of follicles, are placed between the tarsus and lining of the eyelids, in grooves, in the posterior parts of the tarsal cartilages.

These glands are of a brown yellow colour, are disposed in rows, and in a transverse direction, to the length of the cartilage; and, when viewed through a magnifying glass, they appear like a cluster of pearls.

From these glands a sebaceous matter is derived, which exudes through the small orifices of these glands, called the *Puncta ciliaria*, which are placed upon the edges of the eyelids: this prevents the eyelids from adhering to each other, and serves also as a kind of ointment for the eyes.

These glands are more numerous in the upper than in the under eyelids.

Of the Cilia or *Eye-lashes.*

The cilia or eye-lashes, which are not always of the same colour as the hairs of the head, are implanted on the edges of the eye-lids, in double or triple rows. Those of the upper eye-lid, which are longer than those of the under eye-lid, are bent upwards, and those of the under eye-lid are turned downwards. In both eye-lids they are wanting towards the inner angle.

These hairs prevent dust, or other extraneous bodies, from getting into the eye-ball; and also act as a sort of shade to the eye, and they are highly ornamental; and, owing to their particular direction, they do not impede our vision.

Of the Caruncula Lacrymalis.

The caruncula lacrymalis is an oblong body, of a red colour, situated in the internal angle of the eye.

It has constantly a polished surface, from which we may observe frequently two or three hairs growing.

This substance secretes a whitish mucous fluid.

MUSCLES OF THE EYE-LIDS.

Naso-palpebralis, or *Orbicularis Palpebrarum.*

The fibres of the orbicular muscle are arranged parallel to the edge of the eyelid; and the fibres of the muscle are concentric.

This muscle arises by a tendon, from the nasal process of the superior maxillary bone, from the orbitar process of the same bone, and from the internal angular process of the os frontis; its fibres are intermixed with those of the frontal and corrugator, and levator labii superioris muscles, and the outer surface of the muscle adheres to the skin of the eyelids.

The fibres of this muscle decussate each other at the external angle of the eye.

The upper eye-lid is raised by volition, but it is carried down, almost involuntarily; for we cannot suspend the motion for a long time.

The under eye-lid is raised by the action of this muscle.

My Father has concluded, from his experiments, that the *orbicularis of the eye-lid, by its pressure on the upper and under part of the cornea, renders it flatter;* by which the middle part of the cornea is protruded between the edges of the eye-lids, so as to render the cornea more convex, and, at the same time, to increase the distance of the cornea from the lens, or to lengthen the axis of the eye-ball.

Orbito-Palpebralis, or *Attollens Palpebram Superiorem.*

The attollens palpebram superiorem is a long thin muscle, placed immediately under the orbitar process of the frontal

bone: it arises from the dura mater, at the upper margin of the foramen opticum, and forms a broad tendinous expansion, which is fixed to the superior margin of the tarsus.

By this muscle the upper eye-lid is raised.

A small muscle has been lately discovered by Dr HORNER of Philadelphia, which he has called *Tensor Tarsi*.

I subjoin, in the author's own words, his description of the tensor tarsi, from his very valuable book on Practical Anatomy, which he was so polite as to send me.

"At the internal canthus of the orbit is a small muscle, belonging to the internal commissure of the eye-lids, which has not been observed before, or is omitted in the descriptions of the part. That it does not belong to either of the above, or to the orbicularis palpebrarum, a reference to very minute accounts of them, given by the most eminent anatomists, will prove.

"This muscle is about three lines broad and six lines long; it arises from the posterior flat surface of the os unguis, near its junction with the os ethmoides, and passes forwards and outwards, lying on the posterior face of the lacrymal ducts. As it approaches the commissure of the lids, it splits into two parts nearly equal, each of which is appropriated to a duct, and inserted along its course, almost to the punctum lacrymale.

"To get a distinct view of it, the eye-lids must be separated from the eye, and turned over the nose, leaving the tendinous attachment of the orbicularis and ciliaris muscles. The valvula semilunaris is brought into sight by this process, which must be dissected away, and also the fat and cellular membrane underneath it. The muscle is now seen, and by passing bristles through the lacrymal ducts, its connection with them is rendered evident, at the same time that we get a good idea of its size, origin, and insertion. While making this inspection, by turning the muscle somewhat aside, we shall be rendered sensible of another fact of some importance, that the attachment of the inner commissure of the eye-lids to the internal canthus of the orbit is imperfectly described, even by anatomists, of much minuteness, in their accounts. It is

attributed exclusively to the tendon of the orbicularis muscle, so much so, that, in the operation for fistula lacrymalis, we are strictly enjoined not to cut through the tendon, lest a puckering of the eyelids be produced by their line of extension being destroyed. The fact, on the contrary, is, that a ligamentous matter, behind this tendon, passes between the internal ends of the eye-lids and the posterior flat surface of the os unguis; so that, admitting the tendon of the orbicularis to be cut through, this ligament, assisted by the little muscle described, would prevent the dreaded deformity. The internal extremity of this posterior ligament is at least half an inch from the insertion of the orbicularis tendon into the nasal process, and it brings the eye-lids into the curve, commonly seen at their junction. The lacrymal ducts are involved in this posterior ligament, passing along it into the sac, instead of going along the edges of the commissure, as commonly described, just under the skin. The muscle attempted to be described must influence considerably the position of the puncta lacrymalia, by drawing them towards the ball of the eye, and keeping them in close contact with it; it is, therefore, a very efficient means for regulating, so far the lacrymal passages, and for securing the course of the tears. I am indebted to Dr Physick for a further suggestion, in regard to its other uses, which appears highly probable. In cases of extreme emaciation, it is well known, that the adipose matter, around the ball of the eye, is more or less absorbed, causing the eye to sink deeper into the orbit, and consequently to retire somewhat from the lids. The effect of the muscle is to draw the lids backwards, and to keep them applied on the ball. Again, in the elevation of the upper lid, or rather the drawing of it within the orbit, by the levator palpebræ, the tendency of the margin of the lid is to leave the ball; the upper part of the little muscle obviates this tendency. As such appears to be the actions of the part, I must therefore coincide with him, in calling it *Tensor Tarsi*,—a name expressive of its functions.

"I am acquainted with a lady who possesses, in a striking degree, the use of this muscle; its action, in her, being in-

creased much beyond what is commonly observed. It is demonstrated by an ability to draw both the eyelids of one eye towards the nose, at the same time shortening so much the space between the puncta lacrymalia and the junction of the eyelids, that the puncta are buried in the corner of the eye, and carried out of sight.

" It would be interesting to know what is its healthy influence on the condition of the sacculus lacrymalis and lachrymal ducts, in forwarding the tears from the eye to the nose; and whether we are right in attributing this circumstance entirely to the capillary attraction of the puncta, and to the pressure of the orbicularis muscle.

" It is somewhat surprising, that the idea of an apparatus, more perfect than what is commonly described, for regulating the position of the puncta lacrymalia, had not occurred before; and that anatomists, in the dissection of the part, had not observed it. The latter, I think, has arisen from the manner in which the dissection, for the muscles of the eye-lids, is generally performed. Removing the skin, and exposing the orbicularis and ciliaris muscles, we think the dissection completely made; whereas, a most interesting part of the structure is unattended to. Also in working for the lacrymal ducts and sac, this muscle is indiscriminately cut away, with the orbicularis.

" While investigating this subject, my attention was called to a fact, by Dr HARLAN, the observation of which is originally with him. The puncta lacrymalia have a power of projecting themselves beyond the plane of the eye-lid in which they lie, and have an equally obvious power of retracting themselves, so as to do away all appearance of prominence. I do not understand the cause of the first motion, but the second depends upon the muscle just described *."

* The foregoing account of the Tensor Tarsi muscle was communicated to the American Philosophical Society in March 1822.—See Transactions for the year 1824.

Of the Supercilia or *Eye-brows.*

The eye-brows are arched eminences, covered by hair, extending from the root of the nose to the temples, and which differ much in thickness and breadth in different persons. In a few cases, the arches forming the eye-brows meet at the root of the nose.

The eye-brow consists of a thick doubling of skin, covered by hairs of different lengths, which vary in number and colour, and which are placed obliquely; and fat; of part of the orbicularis, frontal, and corrugator supercilii muscles, and of bloodvessels and nerves.

The hairs of the supercilia are disposed downwards and outwards, in order to prevent the sweat from getting into the eye-ball.

The eye-brows are raised by the occipito-frontalis; drawn inwards or towards the nose by the corrugator supercilii; and somewhat depressed by the orbicularis palpebrarum muscles. The eye-brows assist very materially in expressing the various passions of the mind; defend the eye-balls from external injury; prevent the sweat from the fore-head from running into the eye-ball; and, by contracting, protect the eye-ball from too vivid a light.

Fronto-Superciliaris or *Corrugator Supercilii.*

This muscle arises from the internal angular process of the os frontis, and is fixed behind the occipito-frontalis muscle into the middle of the superciliary ridge. By this muscle, the eye-brow is drawn downwards and inwards, by which the skin between the muscles of the opposite sides is thrown into longitudinal folds.

OF THE ORGANS BY WHICH THE TEARS ARE SECRETED, AND OF THE PASSAGES BY WHICH THE TEARS ARE CONVEYED TO THE EYE-BALL, AND FROM IT INTO THE NOSE.

Of the Lacrymal Gland, and its Ducts.

The lacrymal gland is of a yellow colour, somewhat flattened, nearly an inch long, and about half an inch broad,

and consists of numerous lobules, between which the vessels proper to it are lodged. This gland is situated above the junction of the upper and under eye-lids, at the outer and upper part of the orbit, and behind the outer end of the superciliary ridge, by which it is covered and well protected. A small ligament has been described by SŒMMERING which passes from the external and posterior part of the lacrymal fossa under the gland; by which this gland is retained in its place.

The lacrymal gland is supplied by the ophthalmic artery. The nerves of this gland are derived from the ophthalmic nerve. There is also a cluster of smaller lacrymal glands situated between the larger lacrymal gland and the upper eye-lid.

In some animals, as the turtle, the lacrymal gland is of very considerable size, nearly two inches long, and an inch broad; and, in substance, it bears an analogy to that of the pancreas *.

The ducts of the lacrymal glands are not easily seen in the human body: they are placed in the direction of the smaller lacrymal glands.

My Father discovered and described these ducts in the 1758. The lacrymal ducts in the human body are small; they pass out from the interior part of the gland, and do not communicate with each other.

There are usually only five or six ducts to be seen, which terminate on the inner side of the upper eye-lid, near to the outer angle of the eye †.

The ducts of the lacrymal gland are large in the inferior animals. In the turtle, each of the acini of the gland sends out a duct, which, by their union, form a duct capable of receiving a surgeon's probe. The tears are spread over the

* Mr TODD, in the Dublin Hospital Reports, vol. iii., has published some important observations on the diseases of this gland.

† Vide Plate V. of my Father's Treatise on the Eye and Lacrymal Passages, in which the ducts of the lacrymal gland are represented, and bristles are introduced into them.

eye-ball, for the purpose of keeping it moist, and for facilitating its movements. It seems probable that the ducts of the lacrymal gland possess a contractile power, otherwise the tears could not be forced through these ducts. The tears pass across the eye, are diffused by the motion of the eye-ball, and are absorbed by the puncta lacrymalia.

Of the Puncta Lacrymalia *.

There are two puncta lacrymalia, a superior and inferior, through which the tears pass into the lacrymal sac: these canals are not exactly cylindrical, and are narrowest at their orifices, which open on the surface of the eye-lids.

Each punctum is surrounded by a cartilaginous border, by which it is kept always open.

The superior punctum is placed near to the internal angle of the upper eye-lid: it ascends for about one-eighth of an inch, and then turns inwards at a right angle, and descends obliquely to meet with its fellow. The inferior punctum passes downwards, describes a right angle, and then passes obliquely upwards to join the punctum of the upper eye-lid. The puncta pass along the margin of the eye-lids, and approach each other: they are separated by the caruncle, and sometimes form a common duct behind the tendon of the orbicularis muscle; but, in most cases, the puncta open into the lacrymal sac separately †; and these canals are lined by a mucous membrane.

The tears are absorbed by the puncta, in consequence of capillary attraction, and conveyed through the ducts into the lacrymal sac.

Of the Lacrymal Sac.

The lacrymal sac is lodged in a groove formed by the os unguis and os maxillare ‡. This sac is of an irregular form,

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* Vide Plate VI. of my Father's Treatise on the Eye and Lacrymal Ducts.

† Vide a Description of these ducts in Dr Monro *senior's* Observat. Anat. & Phys. published 1758.

‡ Vide Plate VI. Fig. 1. of my Father's Treatise on the Eye and Lacrymal Ducts.

and somewhat approaches to an oval. The lower end of it, which is connected with the nasal duct, is somewhat contracted. This sac is composed of a tough white mucous membrane, of great vascularity, and is covered by the tendon of the orbicularis muscle, excepting at its upper rounded part, and by a layer of condensed cellular substance. This sac is lined by a mucous membrane.

The tears, from various causes, are retained within the lacrymal sac, causing a swelling at the side of the nose, near to the inner angle of the eye: this tumour very frequently may be removed by slight pressure of the finger, as the tears thus pass down into the nose, or a part of the tears regurgitates through the puncta lacrymalia, and is mixed with inspissated mucus. The lower part of the lacrymal sac forms a duct, called *Nasal*, which begins at the inner and under edge of the orbit, and is continued through a bony canal, till it opens in the nose.

The nasal duct, which communicates with the lacrymal sac, is enclosed in a bony canal, formed by the superior maxillary bone and os unguis. The duct, which is about half an inch long, and of various diameters in different individuals, being, at an average, about the size of a surgeon's probe, but sometimes as large as a goose-quill, runs obliquely backwards and downwards, and terminates at the lower surface of the inferior turbinated bone, by a contracted round aperture *. According to Janin, the inferior orifice of the nasal duct is bounded by a valve or sphyncter, which he has asserted prevents the too rapid descent of the tears from the lacrymal sac.

Winslow does not make mention of any such valve. Zinn has, however, described it. It appears to me, that there is a membranous fold, which lies across the extremity of the nasal duct; which, however, is much more apparent in some individuals than in others; and therefore the aperture is not invariably of the same size, and it is gene-

* Vide Plate VI. Fig. 5. of my Father's Treatise on the Eye and Lacrymal Passage.

rally placed opposite to the middle part of the inferior spongy bone.

The nasal branch of the fifth pair of nerves, after supplying the anterior part of the nostrils, and the fore-part of the septum narium, passes to the inner corner of the eye, and is distributed upon the lacrymal sac.

The lacrymal sac and nasal duct are lined by a mucous membrane, which is largely supplied with blood. Like other mucous membranes, it is very liable to inflammation and thickening; and, when this latter takes place to a considerable extent, the flow of tears is interrupted to a greater or less degree.

An unnatural degree of acrimony of the tears, occasioned by their retention, causes the membrane of the duct to become inflamed and thickened, and the mucus secreted by the vessels of the irritated and inflamed mucous membrane is at the same time thicker than natural, which adds to the obstruction. At length, in consequence of the continued inflammation, an abscess takes place; the lacrymal sac bursts externally, constituting the disease called *Fistula lacrymalis.*

If this disease be neglected, the bones of the orbit and side of the nose are sometimes reduced to a carious state, and the disease proves fatal. As the other canals which are lined by a mucous membrane are occasionally spasmodically constricted, it seems to me probable, that the lacrymal canals may be also spasmodically constricted. On account of the small size of the lacrymal passages, and crooked course which they follow, it is very difficult to clean these, when they are obstructed, by passing a probe through them.

If the obstruction to the lacrymal passages be owing purely to inspissated mucus within the lacrymal passages, it may be removed by the injection of warm water; but if there be an inflammation and thickening of the mucous membrane lining these passages, astringent washes are necessary to remove it, together with the application of leeches near to the lacrymal sac. When, on the other hand, spasm is the obstructing cause, sedative applications are requisite.

Lastly, It is proper to add, that a polypus situated in the

nose, is sometimes the cause which obstructs the flow of tears into the nose *.

Of the Ocular or *Ophthalmic Artery.*

The branches of this artery supply the different parts of the eye, its appendages, and the lacrymal gland. The ocular artery takes its rise near to the anterior clinoid process of the sphenoid bone; it passes through the foramen opticum on the temporal side of the optic nerve; then it crosses obliquely over the nerve, passing over the abductor muscle in its progress to the internal angle of the eye.

The branches of this artery are,

The *Lacrymal*, which arises between the levator and abductor muscle of the eye-ball, and divides into several branches, which are spent upon the abductor muscle and the levator palpebræ superioris. A reflected branch supplies the dura mater of the cavernous sinus. A branch passes beneath the globe of the eye, and is spent on the inferior oblique muscle of the eye and lower eye-lid. Several small branches of this artery dip into the substance of the lacrymal gland; and a branch communicates with the deep temporal branch of the internal maxillary artery at the temporal margin of the orbit. A considerable branch of the ocular artery passes in the centre of the optic nerve, called *Arteria Centralis.* It sends off those branches called the *Long Ciliary*, which are spent upon the choroid coat and iris, as has been above explained.

The central artery passes along the axis of the optic nerve, and divides into a number of branches, which are distributed on the inner surface of the retina: some of the smaller branches reach the corpus ciliare; and, in the fœtus, a branch of this artery may be *filled with a red coloured injection, which is distributed on the capsule of the crystalline lens.*

On the nasal side of the ocular artery, branches are sent off

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* The Observations of Treviranus on the Comparative Anatomy and Physiology of the Organs of Vision, published in the Journal Complement, Oct. 1823, merit attention.

to the superior oblique muscle and levator palpebræ superioris, and to the levator and depressor oculi.

The continuation of the trunk of the ocular artery, which follows a tortuous course, enters the nose at the anterior ethmoidal hole. The ocular artery also sends off the infra *trochlear* branch, and the superciliary and palpebral branches, and anastomoses with the nasal branch of the facial artery. The trunk of the artery then ascends, and passes through the foramen supra orbitarium, or foramina supra orbitaria; and has thence been called the *Frontal Artery* or *Frontal Arteries*, which are distributed upon the anterior belly of the occipito-frontalis muscle; and communicate with the anterior branches of the superficial temporal artery.

Of the Corresponding Veins.

The veins of the choroid coat follow a singular course. The smaller branches describe segments of a circle, which, by their union, form a trunk which passes through the sclerotic trunk. These veins, corresponding with the branches of the ocular artery above named, form the large ophthalmic vein, which communicates, at the inner angle of the eye, with the nasal and facial veins.

The ophthalmic vein follows a tortuous course over the optic nerve, and passes backwards through the foramen lacerum into the cavernous sinus.

Considering that the trunk of the ocular artery is about the size of a surgeon's common probe, it is remarkable how little blood is discharged from that artery, when the eye-ball has been extirpated, on account of cancer or fungus hæmatodes. Slight pressure is sufficient to stem the flow of blood.

SECTION III.

OF THE EAR, AND OF THE SENSE OF HEARING.

An organ of hearing has been detected by anatomists, even in the mollusca and insects, and in all vertebral animals. The structure of the most essential part of the ear, on which the sense of hearing chiefly depends, is the same in all animals. It consists of a membranous capsule, filled by a fluid, upon which the smaller branches of the portio mollis are distributed; but the accessory parts of the organ of hearing are differently constructed in the different classes of animals, and admirably adapted to their peculiar economy.

By the sense of hearing we are made sensible to the impressions which vibrating bodies communicate to the atmosphere.

The ear being impressed by the vibratory movements of elastic bodies, transmits these to the brain.

In the mammalia and birds, besides the impression which may be communicated to the nerves of the ear by the tremor of the whole bones of the head, a distinct impression is conveyed, 1*st*, by the chain of bones, cartilages, and ligaments, regulated by their muscles, which connects the membrane of the drum to the membrane of the oval hole.

2*d*, We receive a pretty distinct impression by the medium of the air contained in the cavity of the tympanum of the ear.

3*d*, The impression of sound is conveyed from the membranes of the round and oval holes to the portio mollis, by the medium of the watery fluid which fills the vestible, the semicircular canals, and cochlea.

"When we compare," says my Father, "the mammalia and birds with the amphibia and fishes, we understand the reason of some principal differences of structure.

"The whale, though he seems at first sight amphibious, has the same structure of heart and lungs as man; and is therefore obliged to breathe air frequently, and regularly, and to

live chiefly upon the surface of the ocean: hence his ear is calculated to receive sound *from the air by an external meatus.*

" But in the amphibia, where a part only of the mass of blood passes through the lungs, and which, therefore, possess the power of breathing arbitrarily, or of plunging under water, and ceasing from breathing for a length of time, the ear is constructed so *as to receive the first impression, either from the air or from the water;* but, by means of an Eustachian tube, air is introduced into the cavity of the tympanum when they breathe, and through it the impression is conveyed from the atmosphere, to which their ears are generally exposed, to the bottom of the ear with more force than it would have been by the medium of a watery fluid secreted into the cavity of the tympanum."

In fishes living in and breathing in water, not only *the impression of sound on the surface of the ear is transmitted by the water, but is of necessity conveyed by the same medium to the bottom of the ear:* Hence, it is evident, they have no occasion for a cavity of the tympanum, nor for an Eustachian tube.

At the bottom of the ear we find in all fishes semicircular canals, similar in shape and situation to those found in the mammalia, not much larger, and more extensive in their surface; in order, perhaps, to compensate for the less forcible impression made by the water in them than in us by the air.

Connected with the semicircular canals, we find sacs containing *cretaceous matter*, which perhaps we may think have as much resemblance to the cochlea as to the vestible in our ear, if we reflect that in birds the place of the cochlea is supplied by a short straight tube.

The cretaceous matter, which in the Pisces of Linnæus, and some of his Nantes Pinnati, forms hard and rugged stones, may serve, like the small hard bones of the ear, to convey a more forcible impression to the nerves, and spread out the membranes which contain them.

With regard to the propagation of sound through air, Professor Leslie has remarked, " No sensation is excited, unless the impression made upon our organs be repeated or con-

tinued during a certain short space of time. On this principle depends the whole success of the juggler, who contrives to change the situation of the various objects before us with a rapidity exceeding the ordinary exercise of sight or touch. A brand whirled swiftly round the head gives all the appearance of a circle of fire; and if one press, very hard an ivory ball between his fingers, he will still seem to feel it for several instants after it has been withdrawn.

" To excite the sensation of sound, it is requisite that the aërial pulses should have a certain force and duration. According to some observations, the ear is not affected at all, unless the tremulous impulse communicated to the tympanum last during the tenth part of a second. Every pulsation of a more transient kind is lost absolutely and completely to our organ of hearing.

" On the other hand, the impression of sound is not prolonged beyond the time of its actual production. If it were otherwise, indeed, all sounds would degenerate into indistinct noises; and articulate discourse, which distinguishes man from the lower animals, and constitutes the charm of social life, would have been utterly impossible. This fact, so obvious, and yet so important, shews indisputably, that the propagation of sonorous pulses through the atmosphere is not, in all its circumstances, analogous to the succession of waves on the surface of water.

" Sounds are always heard the most audibly, and at the greatest distance, in a level open country; or, still better, on the smooth surface of a vast lake, or of the ocean itself. The roaring of the cannon in certain naval engagements has been noticed at points so very remote from the scene of action, as might seem, if not perfectly authenticated, to be altogether incredible.

" On the other hand, again, sound is enfeebled and dissipated sooner in alpine regions. Thus, the traveller roving at some height above a valley, descries, with uncommon clearness, perhaps a huntsman on the brow of the opposite mountain, and while he watches every flash, yet can he scarcely hear the report of the fowling-piece."

Sound is propagated with different degrees of velocity, by different substances; and, with the same substance, the velocity varies in consequence of the changes which take place in its constitution.

In the years 1820, and 1821, an extensive and well conducted course of experiments was made on the velocity of sound, by Mr Goldingham, at Madras. By taking the mean of these, made in each month of the year, and again a mean of the whole twelve months, it appears that the mean velocity of sound in the atmosphere of that climate, is 1135 feet per second. The velocity depends on the density, the elasticity, and temperature of the air. By the combined action of these, it varied from about 1100, the velocity in December and January, to 1164, the velocity in July; and, as one would expect, the velocity was greater in the direction of the wind than in the opposite direction.

Sound is conveyed with greater celerity through water, also through solid bodies, than through air. It has been observed, that a person on a frozen river hears the report of a cannon through the ice some time before the sound reaches him through the air.

The celebrated French philosopher Biot ascertained, by experiments made on a line of cast-iron pipes 3120 feet long, that sound passed rather more than ten times faster along the metal than through the air. In the first way, the stroke of a hammer on one end of the pipe was heard after an interval of 26″; but the sound required 2.79″ to reach the ear through the air.

The qualities of sound are very different. The *intensity* of sound depending upon the extent of the vibrations, the greater the vibrations, the louder the sound. The *tone* depends upon the number of vibrations produced in a given time; and sound is acute or grave in proportion to the number of the vibrations. Two strings are said to be in unison, when they perform the same number of vibrations in the same time.

When an acute sound produces twice as many vibrations as a grave sound, it is said to be its octave sound; and is readily

propagated through the different media, air, water, and solid bodies.

My Father proved by his experiments, that sound is communicated as rapidly through water as through air, but the tone is somewhat altered. One of the cavities of the human ear is filled by air, another by an aqueous fluid; and we are capable of hearing by the medium of solid substances, as when a communication is formed between the sounding body and the bones of the skull.

Fishes hear only by the agitation communicated to the water by sounds.

The modifications of sound are very various, and the human ear is capable of appreciating many hundred tones; and by habit we acquire a knowledge of the source from which sound proceeds.

Buffon, who examined with care several persons who had no ear for music, states that these persons did not hear equally well with both ears, and has imputed their want of the musical ear to that defect. But in my opinion, the sense of hearing and the musical ear are widely different. Most men hear well; but many are destitute of a musical ear, and there are many instances of persons who are excessively dull of hearing, who are still passionately fond of music, and even great composers, Such I have heard is the state of that very great composer Beethoven.

Some men who possessed a musical ear are deprived of it, but still retain the sense of hearing; of which I had occasion to meet with a most striking example. A gentleman of middle age, who was much distinguished by his science in music, and his vocal powers, suddenly lost his musical ear, and to so great a degree as to be unable to take a part in duet. He had no one obvious symptom indicating a disease of the brain or ear. He continued in that state for several years. At length he recovered to a certain extent his musical ear; but for four years before his death, which was occasioned by apoplexy, he again lost his musical ear, and all enjoyment in music.

It has been a favourite opinion with some, that the hearing of children is not so acute as that of adults, because the pars

petrosa of the temporal bone during infancy is not so hard as in after life. At the period of birth, children do not seem so much alive to the impressions of sound, as when they are two or three years of age.

By means of the sense of hearing, we possess also all the advantages of *artificial language.*

Quadrupeds hear much more acutely than we do, owing probably to the greater size, form, and greater use they make of the external ear, which being very moveable, may be readily directed towards the sounding body, in the same manner as the conical ear-trumpet (which enables those dull of hearing to enjoy society) catches the undulations of sound. These are accumulated and collected at its narrow extremity, which is deeply lodged within the external passage.

In describing the Ear, it is proposed to divide that organ into the *external* and *internal parts;* which are separated from each other by the membrane of the drum.

The external parts are,—the external cartilage of the ear, and the passage which leads from it inwards to the membrane of the drum, called the *meatus auditorius externus.*

The external ear is somewhat of an oval figure; but it varies much in shape and size in different individuals, in the different sexes, and in different nations. It is somewhat in form like an egg, the larger extremity of which is uppermost.

In some persons the cartilage of the external ear is much higher up than in others.

Holbein has represented King Henry VIII, with his ears very high up; and, on the other hand, the ears of some savages have sometimes been dragged downwards by weights appended to them.

The external ear is composed chiefly of thin and very elastic cartilage, to which is appended a soft organ called the Lobe of the ear, which consists chiefly of fat, cellular membrane, and tendon.

The cartilage of the ear has several risings and depressions upon it. The outermost fold, which describes nearly a semicircle, has been called by anatomists the *helix*, within which, there is an inner ridge of cartilage, called the *antihelix*, which

is composed of two ridges, between which, a cavity somewhat like a boat is placed. Between the helix and antihelix, there is a cavity, which has been called *innominata*. Under the antihelix, there is the large cavity of the ear called the *concha*, which is divided into two unequal fossæ, by a ridge of cartilage, which ends in the back part of the lobe of the ear. On the fore part of the concha, there is a portion of cartilage called *tragus*, which, when pressed inwards, covers the meatus auditorius externus. Opposite to the tragus, there is a prominent portion of cartilage, which is placed at the lower portion of the antihelix: this, from being opposite to the tragus, has been called the *antitragus*.

The cartilage of the ear is covered by a very fine skin, which is kept flexible by means of a number of glands situated under it, which secrete a sebaceous substance; and in the meatus auditorius externus, there are a number of glands which secrete the wax of the ear, hence called *glandulæ ceruminosæ*.

The external ear has several thin muscles fixed into it, which take their rise from the neighbouring parts, and which are intended for raising it, pulling it backwards, and drawing it forwards; but there are few who possess the power of throwing all these muscles into action.

There are also implanted upon the cartilage of the ear, a number of fibres, which, in robust persons only, have a reddish colour, and which have been supposed to give tension to the external cartilage of the ear. These muscles are five in number, and have been so named from their situation. The muscle which raises the external cartilage of the ear, has been called the *Attollens aurem*.

This muscle takes its rise from the tendinous aponeurosis of the occipito-frontalis muscle; and it is fixed into the upper part of the ear, opposite to the antihelix. By this muscle the external ear is raised.

The external ear is drawn forwards by a thin muscle, which takes its origin from the posterior part of the zygoma, and is fixed into the back of the helix; and the ear is drawn backwards by three distinct portions of muscular substance, which

take their origin from the root of the mastoid process of the temporal bone.

These muscles are fixed into the back-part of the ear, which is opposite to the concha auris.

The muscles implanted upon the cartilage of the ear, are,

1*st*, The *Transversus auris*, which takes its origin from the prominent part of the concha, on the dorsum of the ear, and is fixed opposite to the outer-side of the antihelix, and which is said to stretch the concha.

2*d*, The *Tragicus*, which passes between the middle and outer part of the concha, and the point of the tragus, and which pulls the point of the tragus a little forwards.

3*d*, The *Antitragus*, which arises from the internal part of the cartilage that supports the antitragus, and is fixed into the extremity of the antitragus, pulls the point of the antitragus a little outwards, and depresses the extremity of the antihelix.

4*th*, The *Helicis major*, which passes between the upper and anterior part of the helix, and its cartilage above the tragus, which is thereby slightly depressed.

5*th*, The *Helicis minor*, which arises from the fore and under part of the helix, and is fixed into the crus of the helix, and which serves to draw the above parts nearer to each other.

By means of the external cartilage of the ear, sounds are collected and transmitted into the internal ear: hence an imperfection of the external ear, occasions a dulness of hearing; and the greater acuteness of hearing of quadrupeds is probably to be imputed to the greater size of the external ear, and to the accurate manner in which they direct the ear to the source of the sound.

The external ear is supplied with blood by the branches of the occipital and temporal arteries, and by nerves from the portio dura of the seventh pair.

The Meatus Auditorius Externus is that crooked canal extending from the concha of the ear to the membrane of the drum. It is composed of bone and cartilage, which is lined by a very fine skin, and defended from injury by a sebaceous

substance, the wax, and by a number of hairs. This canal is not of an uniform size; for it is rather narrower in the middle than at either extremity.

In some instances, the external passage is awanting, as in a specimen in the Museum; and its capacity is often diminished by a swelling of the softer parts, or by polypi, or other tumours growing from it, or from the membrane of the drum.

In some species of whale, the external passage is very small; and it is so much so in the skate as to give admission only to a hog's bristle.

In the common whale, my Father discovered a substance of an oval shape, within the external passage, which acts like a valve, and prevents the water from over-distending or rupturing the membrane of the drum, when the animal has dived deep.

In the fœtus the external meatus is cartilaginous.

The membrane of the drum is placed at the bottom of the external passage; it is the limit between the external and internal ears. The membrane of the drum is nearly circular in form, and placed obliquely, the upper portion being directed outwards, and the lower inwards.

This membrane is semiopaque in the human body; but, though thin, it is firm, and is concave outwardly.

The membrane of the drum of the elephant is of considerable extent and thickness; and, according to Sir Everard Home, is a distinct muscle, with fibres radiating from its centre to the circumference. This led him to examine, with care, the same membrane in the human body, which he has described as a muscle with radiating fibres.

The bloodvessels of this membrane are disposed in a singular manner: they pass from the circumference to the handle of the malleus.

The membrane of the drum of birds is, in proportion to the bulk of their bodies, greater than in the human body or in quadrupeds; but it is considerably thinner, and there is no appearance of fibres in it.

The muscular fibres of the membrane of the drum are fixed to the handle of the malleus.

Sir Everard Home supposes that, by means of the ac-

tion of the radiated muscle of the membrane of the drum, the ear is adapted to different sounds, and that the imperfect action of this muscle, occasioned by nervous disorders, occasions an imperfection in the musical ear.

The membrane of the drum, in some individuals, is an imperfect septum: there is an aperture in it; so that, if the smoke of tobacco be inhaled, and then forcibly exhaled, while the mouth and nose are kept shut, a part of it comes out at the ear; notwithstanding which, the individual is not deaf, but only somewhat dull of hearing.

In the tortoise, toad, and frog, the membrane of the drum is on a level with the skin of the head.

Of the Internal Ear.

The internal ear consists of the cavity of the *Tympanum*, *Vestible*, and *Cochlea*, and parts communicating with these.

The cavity of the tympanum is placed behind the membrane of the drum. It is of an irregular form, about half an inch wide, and divided into two unequal compartments, by a projecting portion of bone, called the *Promontory*, which is the beginning of the scala tympani. There is a projection in the upper and fore part of the tympanum, which lodges a part of the muscle called *Tensor Tympani*.

The cavity of the tympanum communicates, at its upper and fore part, with the back of the nose, by means of the tube, commonly, though improperly, called *Eustachian*, as it was described by Aristotle. The eustachian tube is in form like a trumpet, with its broader extremity towards the back part of the nose: its orifice is placed immediately above the arch of the palate: it is about an inch and three quarters long, and partly composed of bone and partly of cartilage. It communicates with the upper and fore part of the cavity of the tympanum, by its smaller extremity, which is formed of bone, and which passes obliquely forwards and inwards, towards the back-part of the nose, where it terminates by an aperture which is of sufficient size to admit a goose-quill. This tube is lined by a mucous membrane, which is of unequal thickness. It is so thick next to the back-part of the nose, as to add considerably to the size

of the aperture. By means of this tube, the air passes into the cavity of the tympanum. This mucous membrane lining the eustachian tube is sometimes so much thickened by inflammation, that the air scarcely passes through it into the cavity, which has been supposed to be a cause of deafness. My Father subjected this opinion to the test of experiment in the following manner:

"I placed," says he, "an alarm clock, which rings very loud, upon one cushion, and I stood upon another. Then having stopped my meatus auditorii externi, I set the clock a-ringing, without being able to hear its sound. In like manner, when I held my watch near to the external ear, I heard its sound distinctly; but when I held it within my mouth, between my tongue and the roof of my mouth, without allowing it to touch either, and then stopped my external ears, I did not hear its strokes. The primary use, therefore, of the eustachian tube, is, to furnish air to the cavity of the tympanum, through which the tremor of the membrane of the drum may, in the first place, be communicated to the membrane of the round hole; but, in the next place, as air is conveyed to the cavity of the tympanum in amphibious animals, where the round hole and cochlea are wanting, we must suppose, that the tremor of the air in the tympanum serves to influence the foot of the stapes and membrane of the oval hole, or that two different impressions are made on the membrane of the oval hole *."

The cavity of the tympanum in the skeleton also communicates with the smaller and deeper seated cavity called *Vestible*, by the foramen ovale; and it communicates also with one-half of the cochlea, by means of a rounded aperture, which, in the recent body, is filled up by a membrane.

The cavity of the tympanum communicates, nearly opposite to the eustachian tube, with the cells contained within the mastoid process of the temporal bone: these open into the upper and back-part of the cavity.

The cells of the mastoid process are not invariably of the

* See Monro on Fishes, p. 55.

same size in the human body; they are not found in the fœtus.

These cells are composed of very hard bone, and are well calculated for increasing the intensity of sound.

In the ape, whale, horse, tiger, dog and sheep *, there are cavities which communicate with the cavity of the tympanum; these, by reflecting sound, add to its intensity.

A chain of bones extends across the cavity of the tympanum, the outer extremity of which is fixed to the centre of the membrane of the drum, and the inner extremity is fixed to the membrane of the oval hole.

This chain in the human body, is composed of four distinct bones, called the *Malleus*, the *Incus*, the *Os orbiculare* and *Stapes*, which are firmly united by membranes and ligaments. There are three muscles appropriated to the putting these bones on the stretch to a greater or less degree.

The *Malleus* or *Hammer* consists of a round head, a small neck and handle, and two little processes.

The head of the bone is turned upwards and inwards, and forms an angle with the neck of the bone, and the handle is laid along the membrana tympani, to the centre of which it adheres.

The *Incus* or *Anvil* consists of a body, and two crura, of equal length. It is articulated with the malleus by a capsular ligament, and the surfaces of the bones are covered by cartilage, forming a ginglymous joint; and it is fixed by a ligament on which it moves backwards and forwards, to the side of the mastoid cells.

The *Os orbiculare* is articulated with the long process of the incus.

The *Stapes*, so named from being like a stirrup, is placed horizontally, and is divided into a head, crura, and base.

The base of the bone is of an oval shape, and its edges correspond with those of the fenestra ovalis. The longest crus of the stapes is placed backwards.

There are three muscles by which this chain of bones is moved.

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* Monro on the Ear, Tab. 2. and 5.

The Laxator Tympani.

This muscle arises, by a small beginning, from the extremity of the spinous process of the sphenoid bone, behind the entry of the artery of the dura mater; after which it runs backwards, and a little upwards, along with the nerve called *chorda tympani*, in a fissure of the os temporis, near the fossa that lodges the condyle of the lower jaw.

This muscle is fixed into the long process of the malleus, within the tympanum, where it rests upon the edge of the fissure, between the pars squamosa and petrosa.

This muscle tends to draw the malleus obliquely forwards towards its origin; consequently, the membrana tympani is made less concave, or is relaxed.

Tensor Tympani.

This muscle arises, by a very small beginning, from the cartilaginous extremity of the eustachian tube, just where it begins to be covered by the pars petrosa and spinous process of the sphenoid bone, near the entry of the artery of the dura mater: from thence running backwards near the osseous part of the eustachian tube, it forms a very distinct fleshy belly, below a thin osseous plate, between the pars squamosa and labyrinth; and sends off a slender tendon, which makes a turn into the tympanum, along with the nerve called *chorda tympani.*

This muscle is fixed into the posterior part of the handle of the malleus, a little lower than the root of its long process.

By this muscle, the malleus and membrana tympani are pulled inwards towards the pars petrosa, by which the membrane of the drum is made more concave and tense.

Stapedius.

This muscle arises by a small fleshy belly, from a little cavern in the pars petrosa, near the cells of the mastoid process, before the inferior part of the passage for the portio dura; its tendon passes through a small round hole in the side of the

same cavern; enters the interior part of the tympanum, and is inserted into the posterior part of the head of the stapes.

By this muscle, the stapes is drawn obliquely upwards, by which the posterior part of its base is moved inwards, and the anterior part outwards.

The air within the tympanum increases the force of the sound; to which the tension of the membrane of the drum and of the chain of small bones essentially contributes. The vibrations of sound are thus communicated from the membrane of the drum to the membranes of the round and oval apertures, and the tension of the chain of bones is probably adapted to the kind of sound.

I am much indebted to Mr Corse, for an opportunity he gave me of examining the structure of the ear of the elephant. Upon his return from India, twenty-four years ago, he presented me with two skulls of that animal. I found, that the cavity of the tympanum is proportionally much larger than in man. According to Sir E. Home, the chain of bones is of greater extent, but the semicircular canals are proportionally smaller, though the cochlea be larger.

The cavity of the tympanum of the elephant communicates with larger cells, which are placed in the upper and back part of the head, between the tables of the skull: and these, by adding to the intensity of the sound, render the sense of hearing very acute.

The cavity called *Vestible*, with which the semicircular canals and cochlea communicate, is placed deeper in the pars petrosa of the temporal bone, than the cavity of the tympanum, and between the semicircular canals and cochlea.

In the recent body, there is no communication between the cavity of the tympanum and cavity of the vestible; the oval aperture, which is placed above the promontory in the cavity of the tympanum, being closed by means of a membrane.

The form of the vestible is irregular; it is somewhat rounded, and divided by a ridge into two compartments.

The vestible is lined by a very thin periosteum; and it contains a sac, which is filled by a gelatinous fluid, upon which

the very minute ramifications of the portio mollis, which form a very intricate network *, are distributed.

There are three canals, which describe the greater part of a circle, and which communicate with the vestible.

These canals, according to my Father, are, in the skate, circular; and a smaller membranous canal is included within a considerably larger cartilaginous canal; a circumstance which has been fully described and represented by my Father in his book on Fishes, and which probably paved the way to the discovery of Professor Scarpa †, who found a similar structure in man; but the distance between the membranous and osseous part of the semicircular canals in man, is by no means so great as in the skate.

One of the semicircular canals is called *Superior*, from its situation, and the two others are called, from their direction, the *Oblique* and *Horizontal*. There are only five apertures by which these canals communicate with the vestible, for two of them have a common termination.

These canals are not of an uniform caliber; they are enlarged at their union with the vestible; and form what anatomists have called their *Ampullulæ*.

Of the Cochlea.

This remarkable part of the ear, is differently constructed in different animals, and fishes are destitute of it.

In birds, it consists of a tube divided into two parts by a membranous partition. In the *Cete physeter*, according to my Father, the cochlea is larger than in man; but the semicircular canals are smaller.

In the bat, the cochlea is very large, and forms a projection under the base of the cranium.

In the human body, it is very complex in its structure. My

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* Vide Monro's Nervous System, Plate 31.

† It is worthy of particular notice, that Professor Scarpa has repeatedly referred to my Father's book on Fishes in his description of the Ear.

Father devoted much of his attention to the structure of this organ. His description of it cannot be abridged without being deteriorated; and, therefore, it is subjoined *verbatim* from his last Treatise.

" The central pillar of the cochlea consists of two parts, called *Modiolus* and *Infundibulum*.

" The modiolus is not a solid osseous cone, as has been generally supposed, but may be considered as a hollow cone, containing that branch of the portio mollis which is destined for the cochlea; and is everywhere cribriform, for the passage of the branches of that nerve. The infundibulum is an imperfect osseous funnel, connected to the top of the modiolus. So that the modiolus and infundibulum are two hollow conical bodies, connected together by their small ends. The plate which is between them, and in the centre of both, is cribriform. Around the modiolus, the first gyrus of the cochlea, and half of the second gyrus, are described; the other half gyrus incloses the root of the infundibulum; and the upper ends of the gyri, which communicate with each other, are covered or inclosed by the cupola of the cochlea.

" The partitions of bone which separate the gyri from each other, are not composed of one solid plate, as authors have represented *, but consist of two plates, connected to the modiolus at some distance from each other.

" The osseous root of the lamina spiralis is likewise composed of two plates, connected to the modiolus or root of the infundibulum, at some distance from each other.

" I have already observed, that the modiolus is composed of a cribriform hollow cone, the sides of which consist of two thin plates; and the holes in it are much more numerous than they have been described to be by authors, and are not disposed in the regular manner they have represented them †.

" They are to be seen in every part of the surface of the modiolus, but are most numerous close to the roots of the os-

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* Du Verney, Cassebohm, T. 5. F. 7, 8, 9, 10. Scarpa, p. 10. F. 3. 7.

† Cassebohm, t. 5. f. 10.

seous septa which separate the gyri from each other, and close to the outer sides of the root of the lamina spiralis. They are numerous in the plate between the modiolus and infundibulum; and when the osseous septa, and lamina spiralis, are cut near the modiolus, they are seen in the side of the modiolus, between the two plates which compose the septa and lamina spiralis."

The view which Mr BUCHANAN has published of the several parts of the ear in a moist state, conveys, in my opinion, a more distinct impression of the relative situation of the several parts of the ear than any other engraving I have seen.

Of the Nerves of the Ear.

The internal ear receives its nerves from the seventh pair, which takes its rise from the posterior part of the tuber annulare. It takes its rise by two distinct fasciculi, of unequal size, from the white substance of the tuber: the smaller of these parts is harder than the other, and hence one has been called the *Portio dura;* the other, the *Portio mollis.*

Anatomists differ in opinion as to the origin of this pair of nerves. According to some writers, the portio dura takes its origin from the peduncles of the brain, and also from the side of the fourth ventricle. Others have stated, that it arises from between the corpus pyramidale and olivare, and then winds around the inferior margin of the pons Varolii; and that the portio mollis arises from the side of the corpus pyramidale.

Both portions of the seventh pair of nerves penetrate the dura mater, before entering the meatus auditorius externus.

The seventh pair of nerves is lodged in the meatus auditorius internus, which is situated on that side of the pars petrosa of the temporal bone, which is next the cerebellum.

The bottom of the meatus auditorius internus resembles a sieve: it is perforated by a great number of small foramina, and subdivided into two portions, of unequal size, by a ridge of bone.

The small branches of the portio mollis pass through these small foramina of the bone.

Through the inferior portion, at the bottom of the internal passage, the nerves pass to the cochlea, and a few small nerves to the vestible; and through the upper portion the nerves pass into the vestible.

My Father had stated:

"With a great deal of pains I detached the os petrosum, and the whole external osseous shell of the cochlea, from its interior membranes, and then took out the membranes, with the modiolus and lamina spiralis, suspended by the trunk of the portio mollis; so that, by proper dissection, I could trace, and see distinctly, not only the division of the portio mollis into its larger branches, but the whole progress and termination of these.

"I found, that the portio mollis is composed of two branches, nearly equal in size; one of which supplies the vestible and semicircular canals; and the other the cochlea *.

"That each branch consists of a great number of small cords †.

"That the small cords of both branches pass through different minute holes, into the vestible and cochlea, or, that the bottom of the canal, in the back-part of the os petrosum, commonly called *Meatus auditorius internus*, is cribriform ‡.

"As the osseous partitions, which divide the cochlea into its gyri, as well as the lamina spiralis, which divides gyri into scalæ, are connected to the circumference of the modiolus, we might expect to find the branches of the portio mollis conducted from the modiolus to the membranes lining the cochlea, by means of these partitions, or between or along the outer sides of the two osseous plates which compose them, as well as between the two lamellæ which compose the lamina spiralis, or along the outer sides of these, as we would suppose that the two sides of each scala should have nerves distributed on them in the same manner.

"Accordingly, on prosecuting the branches or fibres of

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* Vide Nervous System, tab. xxx. fig. 1, 2, 3, 4, 5.

† Vide Nervous System, tab. xxxi. fig. 1, 2, 3, A A.

‡ Vide Nervous System, tab. xxix. fig. 12. X Y Z *cc d e*.

the portio mollis, with the utmost attention, I find, that they pass outwards from the cavity of the modiolus, through innumerable minute holes or canals, which every where perforate it. Some fibrils pass between the two plates, which form the septa that separate the gyri from each other. A still greater number of fibrils passes through holes, between the two plates which compose the root of the lamina spiralis. But by far the greatest number of the nervous fibrils perforates the sides of the modiolus, between the osseous septa and the lamina spiralis. The fibrils, which pass through the holes that are nearest to the lamina spiralis, run to the membrane covering the lamina spiralis; whilst those which are nearest to the septa, run, in a contrary direction, to the membranes covering the septa. We perceive, therefore, that the part of the membrane lining each scala, which is the most distant from the modiolus, will be supplied by the terminations of these two sets of fibrils meeting. The nervous fibrils, on the surface of the lamina spiralis, seem larger, and are more regularly disposed, than those that run on the surface of the septa. Two plates are found in the outer osseous part of the lamina spiralis, and the space between them is filled with nervous fibres, from which numerous minute fibrils issue between the outer edges of the two plates. There are likewise minute holes in the sides of each of the plates, which compose the lamina spiralis; and there can be no doubt that the nerves between the plates are connected with those which run on their external surface.

" The last branches or fibres of the portio mollis pass through the cribriform plate, in the top of the modiolus, which is common to it and the infundibulum, to supply the last half-gyrus and cupola of the cochlea *.

" I next observed, that the several branches of the portio mollis, in their whole course along the lamina spiralis, formed an elegant and intricate plexus, by innumerable joinings and separations of their component fibrils †.

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* Vide Nervous System, table xxxi. fig. 1. 2, 3.

† Ibid. 1, 2, 3, 4.

" At the root or osseous part of the lamina spiralis the nerves are white and opaque; but at the flexible and membranous parts they are semipellucid *.

" This change of colour is like to that we observe the optic nerve undergoes on entering the eye-ball to form the retina: and, in both, the change of colour is not very gradually made, but suddenly.

" On comparing the semipellucid outer-part of the lamina spiralis with the retina of the eye, I observed a remarkable difference; to-wit, that in the retina the texture seems pulpy and uniform, without any such appearance of fibres and net-work, as we might expect to observe from the name *Retina*, which has been so long and universally given to it; whereas, in the ear, fibres, and the continuation of an intricate net-work, can be seen distinctly in the semipellucid part of the lamina spiralis, and as far as to its outer edge †.

" I have, therefore, in my lectures, long observed, that the term *Retina* was improper when applied to the nerve spread out on the bottom of the eye, and had been given, not in consequence of accurate observation of the structure, but from a common favourite theory of anatomists, which supposes that the brain and nerves consist of fibres. In the ear, the term may be, with great propriety, applied to describe the appearance of the branches of the portio mollis in their course on the lamina spiralis.

" At the outer-part of the lamina spiralis, the nervous fibres and net-work become much less evident; and, upon the continuation of these membranes, on the inner sides of the gyri of the cochlea, the nerves seem to terminate in a semipellucid pulpy substance, very like to the retina of the eye."

There is also a canal, described by Berengarius, but now commonly called the Canal of Fallopius, which is placed in the upper part of the pars petrosa, and passes downwards and backwards between the fenestra ovalis and external semicircular canal, and ends in the foramen stylo-mastoideum.

The portio dura of the seventh pair passes through the

* Vide Nervous System, tab. xxxi. fig. 1, 2, 3, 4. † Ibid. fig. 4. E F G.

canal above described, and is spent upon the side of the face, head and neck.

The portio dura, in its progress through the canal of FALLOPIUS, gives small branches, which pass inwards and forwards, to the mastoid cells, and also a branch to the stapedius muscle, and it sends off a reflected branch through the foramen innominatum, which joins with the second branch of the fifth pair of nerves. It sends off also a remarkable branch, called *Chorda Tympani*, which passes across the cavity of the tympanum, between the incus and handle of the malleus, and joins the lingual branch of the fifth pair of nerves *.

There are two venous canals improperly called aqueducts one of which, begins at the inferior part of the scala tympani, and terminates in a triangular opening, upon the surface of the dura mater. The other duct is described as taking its rise from the vestible, and terminating between the layers of the dura mater behind the meatus internus.

The nerves of the ear, like those of the eye, sometimes lose their sensibility, especially in advanced life.

In early life, a loss of hearing is often combined with the loss of speech, and in middle life it sometimes proceeds from external violence.

The bloodvessels of the internal ear are derived chiefly from the vertebral artery.

Inflammation of the internal ear is not uncommon, and is often accompanied by fever. The inflammation, more especially in the scarlet fever, runs on to ulceration, by which the chain of bones has in some cases been cast out, which impairs, but does not destroy, the sense of hearing.

This ulceration sometimes induces caries of the bones; and there are in the Museum of this University four instances in which the whole of the ear was destroyed.

The pars petrosa of the temporal bone has sometimes been fractured in consequence of external violence: the membrane of the drum is, at the same time, ruptured, so that more or less blood is discharged from the external ear.

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* Vide MONRO's Nervous System.

SECTION IV.

OF THE TONGUE AND SENSE OF TASTE.

The sense of Taste is very much allied to that of Touch, of which it may be said to be a more exquisite modification.

The tongue, the organ in which the sense of taste chiefly resides, is placed as a guardian, which, together with the nose, enables animals to distinguish between that kind of food which is noxious, and that which is wholesome.

The tongue also assists us in the articulation of words, and in deglutition.

The tongue varies in its size in different animals; and in some it is not merely an organ of taste but also of apprehension.

That the tongue may be rendered a more delicate organ of taste, its surface is elevated into a number of papillæ, and it is very flexible; thus the sense is rendered more acute, a greater surface being presented to the sapid body.

Those substances which are dry do not communicate any peculiar taste, unless dissolved in the saliva: therefore, even the more sapid bodies do not communicate any impression, when there is a want of spittle, and when the tongue is dry, or when, in consequence of disease, the saliva is secreted in too small quantity, or in a vitiated state; and it may be added, that perhaps different substances communicate a more obtuse or a more lively impression upon the tongue, in proportion to their solubility in the saliva.

This sense is not equally acute in all men: this may depend upon original conformation, upon habit, and a variety of other causes.

There are four different sets of papillæ on the surface of the tongue, which are better seen in the living than in the dead body, even after the vessels of the tongue have been successfully filled by a coloured injection.

Dr Grew thought he had seen the papillæ stretched, when a sapid body was applied to them; but though no doubt can

be entertained that the papillæ become more tense, yet I own I have not distinctly remarked them erected, upon the application of a savoury substance.

Perhaps some peculiar tastes affect one set of the papillæ more than another; as some substances make a much deeper impression upon the point, than upon the middle or root of the tongue; while, on the other hand, we seem to perceive the taste of other substances most distinctly upon the back part of the tongue.

Perhaps we judge better of the taste of substances, by their affecting differently all the four sets of papillæ. Whilst we are chewing our food, and when any savoury dish is presented to us, a larger quantity of saliva is secreted than usual; hence, the mouth is said "to water" in common language.

The palate is not insensible to the taste of different substances. BLUMENBACH has described the case of a man who was born without a tongue; he could, notwithstanding this defect, distinguish the taste of solutions of salts, sugar, and aloes, rubbed on his palate, and expressed, by writing, the taste of each.

Though the standard of taste of all individuals be not equally high, yet there is a general accordance as to those bodies which convey the more agreeable or more disagreeable impressions.

At the same time it must be acknowledged, that there are some individuals who have an unconquerable aversion to some kinds of food, which are highly relished by the generality of mankind. This aversion may be original, but it is much more frequently acquired by a surfeit, or by disease. As to the cause of the variety in the taste of different individuals, no satisfactory explanation can be given. It probably may depend upon education, upon habit, upon the different degrees of solubility of different substances in the saliva, and also in part upon a greater or less degree of nervous sensibility, for it cannot depend, as the *epicureans* supposed, upon the geometrical figure of the sapid corpuscles.

The influence of habit upon this sense is very striking: many substances which were at first very disagreeable, and

even a cause of nausea or sickness, as tobacco, become a source of infinite gratification. Those who are in the habit of tasting wines, acquire the power of discriminating the nicer shades of flavour, to which mankind in general are insensible.

But this very exquisite degree of taste is speedily blunted, by tasting in rapid succession a variety of wines or spirits.

There are some diseases which render the sense of taste so preternaturally acute, that, instead of being a source of pleasure, it proves a source of pain; and, on the other hand, from hysteria, catarrh, and other diseases, this sense often becomes obtuse. The tongue of a feverish patient being coated with a brown viscid mucus, is nearly insensible to the impression of sapid bodies.

Though the tongue be the principal, it is not the only, seat of the sense of taste; the loss of that organ impairs, but does not completely destroy this sense, of which the Phil. Trans., and work of BLUMENBACH, affords distinct evidence.

Besides, there are insects destitute of a tongue, but not of the sense of taste. The tongue of some birds is rather an organ of apprehension than of taste; that, for instance, of the woodpecker is hard, horny, and in a great measure insensible. The tongue of the chameleon, is also rather an organ of apprehension than of taste: it is lodged in a sheath in the lower part of the mouth, and its extremity is besmeared by a very viscid glue.

This animal catches its prey, by projecting its tongue to the distance of five or six inches.

In the preceding volume *, the size, figure, and muscular structure of the tongue have been explained; it therefore remains only to describe the nerves and bloodvessels proper to that organ. The tongue is supplied with nerves from three different sources, viz. from the fifth, eighth, and ninth pairs, and it is probable that some sapid bodies affect one set of nerves more than others.

The origin and distribution of the first or ophthalmic part of the fifth pair, have been already described. At present I

* Page 499, *et seq.*

shall describe, only that *branch of the third part of the fifth pair of nerves*, which is proper to the tongue. This branch passes between the pterygoid muscles, and it then sends off *a ganglion*, from which some small nerves pass to the inferior maxillary gland.

This nerve lies beneath the mylo-hyoid muscle, in its progress to the tongue; and at length it terminates on the upper and fore part of that organ.

The *eighth pair of nerves* sends off a branch called *Glosso-Pharyngeus*, which is distributed upon the tonsil, the upper part of the pharynx, the epiglottis, and the middle of the root of the tongue. It passes behind the carotid artery, and towards the muscles arising from the styloid process of the temporal bone.

The *ninth pair of nerves* is connected with the under and lateral portions of the corpora pyramidalia. The nerves of the opposite sides are there conjoined.

Having passed through the anterior condyloid foramen, it is connected with the eighth pair and great sympathetic nerve: it emerges behind the internal jugular vein, and then passes over the carotid artery. It then goes under the mylo-hyoideus muscle, and over the stylo-glossus, hyo-glossus, and genio-hyo-glossus muscles, to which last it gives several branches, and supplies the middle part of the tongue, and joins with the minuter ramifications of the lingual branch of the fifth pair.

Where this nerve passes between the carotid artery and internal jugular vein, it gives off a small branch, which passes down the neck, in front of the internal jugular vein, and has been called *Descendens Noni.*

The tongue is supplied by a large branch of the external carotid artery; which, from being distributed upon the tongue, has been called the *Ranine Artery;* the course of which has been described in page 242 of this volume.

When this artery has been successfully filled with a red coloured injection, the whole tongue assumes a very red colour, and the villi are rendered very conspicuous. On account of

the large size of the ranine artery, wounds of the tongue have been often followed by bad consequences.

The tongue has been very often wounded by the teeth, when persons have been attacked by a fit of epilepsy. Thus, the point has been nearly disjoined from the body of the tongue; and if the lips of the wound be not put together, a sort of fissure in the tongue remains, which has callous edges.

Hence surgeons have recommended, that, when the tongue has been severely wounded, the opposite sides of the wound should immediately be put together by a suture.

A good deal of blood has been sometimes lost by a wound of the tongue, or during the performance of surgical operations upon that organ. It is very difficult to stop the bleeding, as a ligature or compress cannot be applied, nor are styptics of use. It has therefore been recommended by the surgeons of the Continent to apply the actual cautery. According to JOURDAIN, a bleeding from the tongue may sometimes be stopped, by putting a piece of ice under it.

From what has been stated respecting bleeding from the tongue, it is evidently prudent on the part of the surgeon to remove a part of the tongue when cancerous, by a double ligature, according to the method proposed by Sir E. HOME.

From what has been above stated as to the large size of the arteries of the tongue, much caution is requisite in dividing the frænum linguæ: when it is so short that the tongue cannot be sufficiently raised, the child is prevented from sucking, and, in after life, the articulation is rendered indistinct. The best instrument for the purpose of cutting the frænum, is a pair of scissars, with their points sheathed, or with blunt points; and no more of the frænum should be divided than is absolutely necessary to admit of the free motion of the tongue.

It may be also observed, that the tongue often acquires a most unnatural size from inflammation.

In consequence of the application of very stimulating substances, the tongue sometimes in a few minutes acquires so great a volume, as to render the articulation very indistinct,

and even to impede deglutition and breathing to a certain degree.

I had occasion to see an instance, in which it was quickly very much enlarged, in consequence of taking into the mouth, by mistake, the aqua potassæ. In that instance, the inflammation and swelling were so much reduced in the course of four hours, by the continued application of ice, that the patient could speak quite distinctly, and was relieved from acute pain in the tongue.

The inflammation of the tongue sometimes passes on to suppuration, and even to mortification.

The inflammation of the tongue has been sometimes removed, by opening the veins of that organ; but it is difficult to get at the veins, when the tongue is much swelled.

The tongue has been sometimes displaced. Thus, when the flow of the saliva through the duct of the inferior maxillary gland is interrupted, the duct, from distention by the saliva, swells out into a tumour, which presses the tongue to the roof of the mouth; and as the patient speaks very indistinctly, and croaks somewhat like a frog, the disease has been called *Ranula.*

Such a tumour is semitransparent, and varies from the size of a pea to that of a hen's egg; and, when large, it impedes the breathing and deglutition.

Ehrlich observes, " Un jour un homme demanda à parler à M. Cline. On le fit entrer dans l'antichambre: tout à coup M. Cline, entendit tomber quelque chose et des plaintes et gemissemens d'une personne. En ouvrant la porte il vit l'homme en question, etendu par terre, sans connoissance et pret à étouffer. Cline soupçonna la presence d'une corps étranger dans la trachée-artère, et se disposoit deja à pratiquer la bronchotomie, lorsqu'il apperçut la langue du malade poussée fortement en arriere par une grenouillette qui de plus faisoit saillie au-dehors. Il y plongea une lancette, et donne par la issue à une grande quantité de pus et de lymphe.

" Le malade, revenu à lui, declara que depuis longtems il avoit porté une tumeur considerable sous la langue, sans en être gêné ni en parlant ni en respirant; que cette tumeur,

pendant le peu de minutes qu'il avoit attendu dans l'antichambre, avoit acquis très subitement un acroissement si considerable qu'elle l'auroit infailliblement étouffé sans le prompt secours que M. CLINE lui avoit donné."

Such tumours sometimes burst spontaneously, and the patient is relieved.

SECTION V.

OF THE SKIN AND SENSE OF TOUCH.

THE sense of touch resides in the skin, or rather in the extremities of the nerves proper to that organ.

Every part of the human skin is not equally sensible: this depends upon the number of nerves proper to certain parts of the skin, upon the thickness of the cuticle which covers these, and also upon certain parts of the skin being elevated into papillæ, which are the more immediate instruments of sensation.

We are less apt to be deceived by this sense, than by the senses of smelling, tasting, hearing, or seeing; for there is no intervening medium between the fingers and the substance that is touched, excepting the cuticle.

Without the aid of touch the senses of sight and hearing are imperfect.

By the sense of touch a precise and determinate idea is gained, of several of the properties of external objects, as of the hardness, softness, roughness, or smoothness, of heat and cold, and of figure.

There are innumerable varieties as to the degree of feeling. Much depends upon the rapidity with which different bodies are applied.

I recollect well to have been much surprised by an exhibition of Madam GIRANDELLI, who drew a box with a dozen of lighted candles along her arm, dropped melted sealing-wax upon her tongue, and impressed it with a seal, and put her naked foot upon melted lead.

These facts at first seemed astonishing, and the more espe-

cially, as her skin was not rendered fire-proof by any coating, as was ascertained by a minute examination of her skin by Dr DUNCAN *junior* and myself, immediately after her exhibition. She was protected, I apprehend, by the rapidity with which the heated substance was applied, by the wonderful power which the body possesses of resisting the influence of great heat or cold; by a certain degree of insensibility of the skin; and probably, also (as Dr DUNCAN supposed), by the heated body applied producing suddenly an atmosphere between itself and the skin *.

There are many examples of a morbid sense of touch; it may be either morbidly acute, or morbidly obtuse.

There are many modifications of too great a sensibility of the skin.

There is a *painful tenderness of the skin*, which is experienced even from slight pressure, and is often a concomitant of debility.

Itching is another modification of morbid sensibility; it is often occasioned by some local or general irritant, or from the secretion of morbid matter from the skin; and there are many who have a morbid sensibility as to heat and cold.

The sensibility of the skin is also frequently more *obtuse* than is natural: this loss of sensation or numbness is general or local; it is often limited to one of the arms, or even to a finger.

This obtuseness, as to the sense of touch, is a very common symptom of apoplexy, palsy, epilepsy and syncope.

Many animals are provided with particular organs, which are exquisitely sensible, and in which the sense of touch is extremely acute.

The bill of the swan, goose and duck, is exquisitely sensible, and provided with many large nerves. I have repeatedly examined the nerves of the bill of the duck, which are derived from different sources. These nerves repeatedly com-

* BOERHAVE and HALLER have recorded many very striking instances of smiths and glass-blowers, who resisted the application of heat, and which these authors have imputed to the thickness and compactness of the cuticle.

municate with each other: thus the animal, when in search of its food amongst the clay, at the bottom of rivers or ponds, is enabled *to exercise, probably, at the same instant, the senses of touch and taste.*

The proboscis of the elephant, and the snout of the hog, are exquisite organs of touch. By means of the whiskers in the tiger, the lion and the cat, the seat of the organ of touch is extended, and, at the same time, that sense is rendered very acute, there being, at the root of each bristly hair, a plexus of nerves, which must be affected by every body with which the whisker comes into contact.

There is not a more striking circumstance than the means by which the Author of Nature compensates the loss of one sense, by an uncommon degree of perfection of another. Nothing is more surprising than the acuteness of touch in the blind; thus they have been said to be even capable of distinguishing colours. I have often viewed, with astonishment, the manner in which two persons, born deaf and dumb, lived together, and contrived to communicate their ideas, by touching different parts of the face, arms and hands.

My reader would do well to turn up to the case of MITCHELL *, which has been so faithfully and ably pourtrayed by Professor DUGALD STEWART and Mr WARDROP, and which exhibits so very striking a picture of the above remark. This youth was born blind and deaf, and therefore his connection with the external world was derived from the senses of smell, taste and touch, which he possessed in an extraordinary degree of perfection. By *the sense of smell* he distinguished, in a moment, strangers.

It may not be improper to add, that, according to Professor KNOCK, there are many insects that have no tongue; and he supposes, that in them the sense of taste is resident in the posterior pair of *palpi*, or feelers.

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* See History of JAMES MITCHELL, a boy born blind and deaf, with an account of the operation performed for the recovery of his sight. By JAMES WARDROP, Esq. London 1813.

GENERAL OBSERVATIONS ON THE HUMAN SKIN.

The skin, the common integument, forms a dense covering for the protection of the subjacent parts.

The thickness of the skin varies in different parts of the body. It is thinnest where flexion is required, and on the most delicate and sensible parts of the body. The skin on the chest, on the back, and outer side of our limbs, is thicker than that of the lips, eye-lids, glans penis, clitoris, labia pudendi, or extremities of the finger.

The skin of the female is finer than that of the male.

The skin not only covers the surface of the body, but is reflected inwards into the canals which open on the surface of the body, and is continuous with the mucous membranes which line them.

The surface of the skin is kept moist by exhalation.

On those parts of the skin which are exposed to the air, or to friction, as that of the nose and axillæ, there are a number of *pores*, or open mouths of ducts, from which a viscid matter may be squeezed out, which, in some cases, is very tenacious; and, *from being forced out in long-shaped masses, has been mistaken for worms.*

By a warm atmosphere the skin is relaxed, and a greater quantity of matter is exhaled, especially when the body is naked; and, on the other hand, by cold the skin is contracted and corrugated.

Considerable heat applied to the skin occasions a sensible redness, which is followed by blistering.

When the dead skin is exposed to heat and moisture, it becomes brownish; then of a yellow green colour; and, lastly, it assumes a dark-brown hue, emitting, at the same time, a very offensive gas, and it is covered by a mucus which communicates to wood a stain of a deep brown colour; and hence it removes paint from wood. This mucus is produced by the decomposition of the body, and consists of a fatty substance, combined probably with ammonia.

By boiling, the skin becomes very white, it swells, is softened, and converted into a pulp; and, by long boiling, is

changed into a jelly. When dissolved by boiling, it forms a viscid liquor, which, by evaporation, may be converted into glue, and a small proportion of membrane only remains.

The skin possesses *a remarkable degree of toughness and elasticity;* thus it is occasionally much distended in cases of ascites or pregnancy, and soon regains its original bulk upon the cause of distention being removed. But, in some cases of diseased scrotum, and in advanced life, the skin loses a considerable share of its extensibility, probably in consequence of its texture being altered; and, in some instances, it bursts, being incapable of further extension.

The skin of a young fœtus is a viscid substance, which may be readily torn; and the fibres of the true skin being gradually added, it acquires greater firmness.

There are no wrinkles on the skin of a child, and it is more largely supplied with blood than in the adult.

In old age the skin becomes more dense; it seems dry and hard, and loses its red colour, especially upon the cheeks.

On the surface of the skin there are a number of furrows, of different sizes, and which follow different directions, from the form of the subjacent muscles.

Of the Colour of the Skin.

It is rather the province of a writer on the natural history of man, than of the anatomist, to attempt to describe all the varieties of the human complexion. I shall limit my remarks to the more striking peculiarities.

The colour of the skin is one of the most striking properties of this tissue, and is very different amongst the inhabitants of different parts of the world. From that circumstance, the human race may be arranged into five classes. But it must be acknowledged, that such a classification is liable to many exceptions. The shades of colour are infinite, and are various even amongst the inhabitants of the same country.

The human skin exhibits various shades of white, brown, and black.

First, White, accompanied with redness of the cheeks, which is the character of all Europeans, excepting the Lap-

landers, the Western Asiatics, and inhabitants of Northern Africa.

But the above observation must be received with a certain limitation; for FORSTER *, and DAMPIER †, tell us, *that a blush is perceptible on the cheek of the fairest Otaheite and Tunganese women.*

The Albino forms a very singular variety of people, with a dead white or reddish skin; and these people have been observed in almost all parts of the world. The skin of the Albino is remarkably rough, which has given rise to the notion that the white colour proceeds from disease; but I have seen several of these people, who, though not robust, seemed to be in perfect health.

There are almost endless varieties as to the shade of colour. According to JEFFERSON ‡, WINTERBOTTOM §, and WAFFER ||, there are whites among the blacks of Africa: this peculiarity exists from birth, and it is propagated from father to son.

Dr WINTERBOTTOM informs us, that the parents, brothers and sisters of a white African woman were black; she was married to a black man, and had a black child.

The *second* class includes those people whose skin is of a yellow or olive colour, as the natives of Asia.

The *third* class includes the natives of the American Continent, who have a reddish or copper-coloured complexion, of which there is a great variety of shades.

The *fourth* class comprehends the inhabitants of the majority of the Islands of the Pacific Ocean, who are of a brown or tawny complexion.

The *fifth* and last class comprehends the natives of Africa, excepting those of its northern and southern extremities, the natives of New Holland, Van Dieman's Land, New Guinea, and the New Hebrides.

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* Notes on Virginia. † History of Sierra Leone.

‡ New Voyage and Description of the Isthmus of America, p. 134.

§ Observations made on a Voyage Round the World. He observed a blush on the fairest of the Otaheite women. || Voyages, vol. ii. p. 40.

By intermarriage, the children exhibit, as to complexion, the middle tints between the father and mother, and what is remarkable, these children, called *Mulattoes*, (the first generation between Negroes and Europeans), have exactly the same colour, in all climates; for it matters not whether they be born in Europe, Africa or America.

Europeans and mulattoes produce *Mestizos*; in them the skin has a slight brown tint, and the cheeks are red. In the Dutch colonies they often have blue eyes and fair hair.

The stain of the black blood is principally visible in the organs of generation; the scrotum is blackish in the male, and the labia pudendi dark or purplish in the female.

Zambos are the produce of Negroes and Americans.

Of the Layers of the Skin.

The skin is composed of four layers; of the cuticle or epidermis, of the rete mucosum, or corpus mucosum, and of the true skin, with a number of papillæ upon some parts of it.

Of the Cuticle, Epidermis, or *Scarf Skin.*

The cuticle is common to all animals: it is firm and hard in its texture in land animals, but smooth and pliable in aquatic animals.

The cuticle is found even in the youngest fœtus; and while the fœtus is in utero, it is coated by a more copious secretion from the sebaceous glands, than after birth.

The cuticle covers the whole of the true skin, excepting under the nails: it covers thousands of vessels which transpire or absorb; and the various papillæ destined to render the sense of touch and taste more acute. The cuticle is thin, of a greyish colour, and adheres very intimately to the subjacent true skin, by a number of fine threads: in the dead body, it can only be separated after a slight degre of putrefaction has taken place, or by putting the skin into boiling water, for about a minute.

During life, by the application of a blister, by collections of matter, and by the effects of disease, the cuticle may be detached from the true skin; and when thus raised, pricking

does not give pain, as it is insensible; but though devoid of sensibility, it cannot be said to be a dead substance. The vital power of the cuticle is not great, but we know that it is constantly renewed when abraded, and the renewal may be accelerated by the application of different substances.

The cuticle of the Negro and European is nearly of the same colour, and it is almost transparent; so that the colour of the subjacent part shines through it.

Mr Chevalier * informs us, that upon examining the inner side of the cuticle by a microscope, magnifying 140 times, he observed an infinite number of minute velamina, regularly arranged, of exquisite tenuity, presenting a follicular appearance, and separated from each other by bands of a thicker substance, crossing and intersecting them.

The cuticle takes an exact impression of the folds and risings of the true skin; and hence is disposed in lines, in many parts of the body.

There are different kinds of wrinkles on the surface of the cuticle. One kind is occasioned by the contraction of the muscles under the skin, as those of the fore-head, and the outer angles of the eyes, or around the mouth; the former of which is occasioned by the orbicularis oculi; the latter by the sphincter oris.

There are broad furrows or wrinkles on the palms of the hands and soles of the feet, and at the joints of the fingers, occasioned by the movements of the fingers and thumbs: these are distinct when the fingers are extended, and are owing to the skin being looser over these parts. There are wrinkles in the countenance of the aged, owing to the absorption of the fat; for in them the skin does not contract, so as to accommodate itself to the subjacent parts.

The cuticle is of various degrees of thickness in different parts of the body; and it may be said to be the regulator of the degree of sensibility.

The degree of perfection of the sense of touch depends upon the cuticle: where it is thin, as upon the lips, glans penis,

* Lectures on the Anatomy and Functions of the Skin, p. 133.

or clitoris, there the sense of touch is very acute; and, on the other hand, where it is thick and hard, there the sense of touch is obtuse.

The internal surface of the cuticle is of a greyish green colour.

When moisture is applied to the cuticle, it assumes a white opake hue.

The cuticle is in a constant state of change, and is detached in dry, branny, small, and thin scales, which may be seen sticking to the inner surface of black silk stockings. The surface of the cuticle, in these circumstances, is uneven; and these scales may be detached by hard rubbing: indeed, by long continued hard rubbing, the whole cuticle is worn down.

The cuticle of many animals comes off at certain seasons. From serpents and caterpillars it comes off as an entire sheath.

The cuticle possesses a considerable share of flexibility, by which it readily adapts itself to the form of the parts with which it is connected.

The cuticle is not so elastic as the true skin, and it does not entirely regain its original size after great extension, and cannot be extended to a considerable degree without cracking or tearing, as generally happens when tumours are situated under the skin.

When moisture is applied to the cuticle, as when a poultice is put on, it assumes an unnatural whiteness and opacity, and is thrown into wrinkles.

The nerves of the cuticle are not visible; it possesses no degree of sensibility, it may be cut or punctured without giving pain.

The cuticle is perforated by the exhalant branches of the arteries, by absorbent vessels, and by hairs.

It is still a matter of doubt, whether or not the vessels of insensible perspiration be the same as those of sweat. The analogy of the dog, who perspires but does not sweat, affords an argument in favour of the matter of sweat and perspiration being derived from a different set of vessels.

There have been some anatomists who have considered the cuticle as porous: upon this opinion my Grandfather has ob-

served, " Quod si vera esset hæc de poris doctrina, admotis viscidis hisce substantiis cuticula a liquoribus subtus effusis in bullam attolleretur, et innumeris documentis cognitum habemus nullas ejusmodi bullas attolli, ac proinde qui per cuticulam emittuntur liquores, neutiquam subter eam prius effusos esse.

" Cum cuticula in vesiculas attollitur, siquidem quod hi volunt verum esset, necessario per hos poros liquor transiret. At haud paulo secus sese res habet, nisi enim liquoris pondus aut extensu aut vis externa adhibita cuticulæ partes dilanient, nulla ei elabendi facultas permittitur *."

The cuticle serves as a defence to the true skin, and prevents too great evaporation from its surface.

Every practical anatomist well knows how quickly the true skin dries, sticks to the neighbouring parts, and assumes a horny appearance, when the cuticle has been removed. In short, the cuticle is of such a dense structure as to prevent the shrivelling of the skin from too great evaporation from its surface, which thereby might become too rigid.

The cuticle does not merely form the external lamina of the skin, but is reflected inwards, into the nose, ears, lips, mouth, pharynx and gullet, anus and vagina, and it forms sheaths for the hairs.

The cuticle, when traced into the canals above named, becomes gradually thinner and thinner, and at last so much so as to be traced with great difficulty. I have traced the cuticle as far down as the cardia, where it terminates by a semicircular edge, as depicted in my Thesis; but in some animals, as in the horse, it may be traced over only half of the stomach.

Some authors are of opinion, that the cuticle lines the villous coat of the intestinal canal, but I entertain doubts as to that opinion, for it is not visible by dissection, by the knife, or by the application of boiling water, nor have I seen it ele-

* Works, page 711. Quarto Edit.—The observations of Mr Herbert Mayo on Cuticle and Horn in his Anat. and Physiol. Compt. No. I. are well worthy the attention of the reader.

vated or abraded from the surface of the intestines by disease.

The cuticle is less prone to putrefaction than any other parts of the body, and may be taken off from the hand of a body that has become putrid, like a glove.

The bloodvessels of the cuticle are so small that a red injection cannot be thrown into them.

When it is detached from the subjacent true skin, a number of threads may be observed passing into it; hence it is nourished by these vessels.

It has been supposed, that when the skin has been irritated by a blister, a part of the fluid is derived from the vessels of the cuticle.

Of the Chemical Analysis of the Cuticle.

The cuticle, according to Mr HATCHETT, bears a very strong resemblance to jelly.

Cuticle burns like horn when thrown into the fire, and gives out a similar smell.

By means of nitric acid the cuticle becomes thicker, assumes a lemon colour, and, if the acid be applied for twenty-four hours, it is converted into a pulp.

The sulphuric acid gives to the cuticle a brown colour; it renders it somewhat like glue both in colour and consistence.

The caustic alkalies dissolve the cuticle, and form with it a substance somewhat like soap.

Of the Nails.

The nails constitute a part of the cuticle; they are concave internally, and convex externally; are nearly transparent, and hence have a reddish colour, from the colour of the skin shining under them.

The nails are composed of layers, which are made up of fibres, and the longest fibres of the nails are outermost; therefore the nails are thinnest at their edges: like horn and cuticle, they are insensible, except where they adhere to the skin.

The nails are said to be fixed by their roots by a semilunar fold of skin. The term *root* is, however objectionable, as

plants torn up by the roots are destroyed, which does not happen to nails.

The nails consist of inspissated albumen, and contain a small proportion of phosphat of lime.

The nails, as organs of apprehension, are of great use, and assist us in picking up small bodies.

Of the Corpus Mucosum or Rete Mucosum.

The corpus mucosum forms the second layer of the skin.

The corpus mucosum, which is situated under the cuticle, gives colour to the skin, and it has been so named, as it is of a soft mucous nature. Being perforated by the hairs, and by many vessels, it has sometimes been named rete mucosum.

The corpus mucosum covers every part of the true skin, excepting under the nails, and connects it to the cuticle.

Haller, Camper, Blumenbach, and other anatomists, entertain doubts as to the existence of the corpus mucosum in persons with a fair complexion.

I confess it cannot be shewn very distinctly excepting in the Negro: it is not like a net-work or web of any description, nor is it so coherent as mucus: it is a substance very diffusible in water. If the corpus mucosum does not exist, it is very difficult to explain the different shades of colour of the same person at different seasons of the year, the difference in the complexion of the ploughman, and the miner, and the immediate formation of a white spot upon the Negro's skin, by the application of a blister. These facts in my mind are of easy explanation, if the existence of the corpus mucosum be admitted, but on any other ground they are inexplicable.

The corpus mucosum gives colour to the skin, by shining through the semitransparent cuticle, and being different in its shade, gives the variety in the complexions of different nations.

The corpus mucosum is not of an uniform thickness: hence the palms of the hands and soles of the feet of the Negro are not of so dark a colour as the rest of his body; and even in individuals of the same nation, it is darker in some parts of the body than in others, as in the arm-pits and eye-lids.

It differs not only in colour, but in thickness, in different nations; being not only of a darker colour, but much thicker and stronger, in the Negro than the European.

There is generally a relation between the colour of the skin, and that of the eyes and hair. If the complexion be dark, the eyes are so,—but if fair, the eyes are light.

The corpus mucosum, like the paint on the choroid coat, and iris of the eye, and colouring matter of the hair, is probably awanting in albinœs: hence, the remarkable degree of whiteness of their skin.

When oxymuriatic acid is applied to the skin of a Negro, it assumes a dirty yellow colour, and, according to Fourcroy, the black colour returns in a few days.

I have seen a Negro with a great many large white spots on his body, which I was informed were not occasioned by blisters, or any other artificial means.

Authors make mention of women becoming of a dark colour during pregnancy; and of the same happening to men from vexation of mind, and of Negroes losing their colour from old age and disease.

It is a very remarkable circumstance, that the corpus mucosum around the nipple of a woman when she becomes pregnant, should become brown, and so universally so, as to render this appearance one of the most certain signs of pregnancy.

The corpus mucosum is slowly regenerated, and some time elapses before a part which has been blistered regains its original colour.

The corpus mucosum is probably secreted by the vessels of the true skin, as the pigmentum nigrum is derived from the vessels of the choroid coat of the eye. It is probably an organized substance, and provided with bloodvessels; otherwise we cannot explain why it should sometimes receive a dark tinge from the nitrate of silver, which evidently passes through the circulating system.

Of the Cutis Vera or true skin.

The surface of the true skin corresponds exactly with that of the cuticle.

The cutis vera is a white, strong, elastic, fibrous, membrane, which is largely supplied by bloodvessels and nerves, and which differs much as to its thickness in different parts of the body. It is thicker in the back than in the fore part of the body, and thinner in the scrotum, penis, labia pudendi and breasts, and is thinner on the inner than the outer sides of our members.

When the cutis vera has been well washed, it is of a white colour, and is found to be more dense on its outer than on its inner surface.

The true skin is made up of small and dense white fibres, which differ as to size in different parts of the body, are very intimately interwoven with each other like those in the felt of a hat, and cross each other in every direction, so that it is impossible to trace their course: between the fibres small masses of fat are interposed, and also a quantity of cellular substance, which passes even to the outer surface of the true skin. This is made evident in cases of anasarca; the water passes through the cellular substance of the true skin, the fibres of the skin are separated, the cuticle gives way, and the water is discharged.

The skin of the extremities of the fingers and toes is disposed in ridges.

Every part of the true skin is not equally vascular; there are more bloodvessels on the outer than on the inner surface of the skin.

There are a *number of papillæ*, or small processes of different sizes, on the surface of the cutis vera, and which are most numerous in the more sensible parts of the body, as upon the lips, the glans penis, clitoris, and at the points of the fingers and toes, where they are placed in double rows upon the ridges.

The papillæ of the hands and feet are most distinct when the cuticle has been removed by maceration, or after a penetrating injection has been thrown into the vessels of the cutis vera.

On the extremities of the fingers and toes, the papillæ follow a spiral course.

These papillæ have been commonly supposed to be formed by the terminations of the nerves of the skin, and of a plexus of small bloodvessels. I have employed the word supposed, because, on account of the extreme smallness of the papillæ, it is extremely difficult, perhaps I might say impossible, by dissection, to trace the minute filaments of the nerves into these. In the skin of the belly and thighs of women who have had children, there is a growth of an imperfect new skin, between the other parts of the true skin. Has the skin a muscular action? In the forehead, neck, and perhaps scrotum, there are muscles which somewhat resemble that muscle called *Panniculus carnosus* of the horse and dog, which lies immediately below the skin, and which corrugates the skin of the animal.

The true skin is perforated by lymphatic vessels, but their orifices cannot be demonstrated in the human body, probably on account of their small size; but in the skate-fish, as an injection passes from the larger trunks into the smaller branches of the absorbents, the orifices of these vessels can be shewn*.

Chemical Analysis of the Cutis Vera.

The true skin consists chiefly of jelly; unites with tannin and forms leather, a substance that is insoluble in water; and, owing to this combination, leather possesses its peculiar properties.

The cutis vera is a peculiar modification of jelly; and partly by the compactness of its texture, and partly by the viscidity of the jelly of which it is formed, resists the action of moisture; for those skins which dissolve the most readily in boiling water, afford the worst glue.

Of the Sebaceous Glands of the Skin.

The skin is covered with an oily matter, which stains linen that has been worn for some time; especially that part of it which has been in contact with the axillæ and perineum.

This oily matter is secreted most abundantly from those parts of the skin which are exposed to friction.

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* Vide Dr Monro on Fishes.

In some parts of the body there are small rounded bodies under the skin: the ducts of these glands, which are large, open on the surface.

These ducts are most obvious in the nose of the male, and a sebaceous matter may be squeezed out from them.

But there are other parts of the surface, from which no such sebaceous matter can be expressed, nor are the sebaceous glands to be found.

The quantity of matter perspired is greater than that of all the other excretions; it varies in different climates; the warmer and drier the climate, *cæteris paribus*, the greater the quantity of perspiration.

Sanctorius, who made many experiments upon the quantity perspired, has stated, that, on an average, 5 lb. passed off by perspiration, when he took 8 lb. of food.

With regard to the chemical nature of the matter which is perspired, we are yet in the dark: it evidently contains a good deal of water; and from the very peculiar odour of the matter perspired, it contains a good deal of animal matter; and, according to Cruickshanks and Berthollet, the phosphoric acid.

Some authors have supposed that the skin produces on the air the same changes as the lungs.

The skin is amply supplied by nerves, and is exquisitely sensible.

Large nerves can be traced into it; more especially towards the extremities of the fingers and toes.

Whether new skin is formed from the edge of the original skin, or from the surface of granulations, is doubtful. We see it distinctly growing from the edge of the original skin. We see also sometimes an appearance of little islands of skin, formed on the surface of an ulcer.

New formed skin is less vascular than the original skin.

New skin is not so strong, and is apt to burst out.

Of Hair.

Hair is proper to all the class Mammalia, not excepting whales and dugongs. It differs greatly in quantity, quality

and colour; and, generally speaking, is most abundant in parts most exposed, and in cold climates.

There is a very great difference as to the quantity and distribution of hair on men and quadrupeds. The former may be said to be almost destitute of hair, when compared with the latter; and in men, the hair is accumulated on the head, forming one of the greatest ornaments of man.

The hair, also, of the different inhabitants of the globe, differs not merely as to its colour, but also as to its consistence and length, being in the African short, wooly, and curled; and there are nations, as the African, Mongolian, Chinese and American *, amongst whom the beard is very thin, and almost awanting.

Fishes, reptiles, amphibia and mollusca, have no proper hair.

Different names have been applied to hairs, from their situation, as *Beard*, *Whiskers*, *Eye-lashes*.

The colour of hair varies much amongst different nations, and has a relation to the colour of the skin, being white in the Albino, darker in the European, and black in the Negro; and when the skin of the Negro is in part white, the hair that grows upon that part is also white.

Hairs differ as to form; generally they are round, but sometimes they are flat, or two-edged.

There is much difference as to the growth of hairs; that of the head is sometimes so long as to reach the knees; but that of the beard of the male seldom grows longer than to touch the uppermost part of the chest.

The hair of many animals is long and straight, but in others crisped. When crisped, it is called *Wool*; when stiff, *Bristles*; and when inflexible, *Spines*.

The hairs are imbedded in the cellular substance, and grow from roots, or bulbs, as they have been called, which are very conspicuous in quadrupeds. The hairs pass through the skin

* Vide Ulloa. The Indians have no beard; and the greatest alteration, occasioned by their arriving at the years of maturity, is only a few straggling hairs on the chain, but so short and thin as never to require the assistance of the razor.

and cuticle, which they somewhat raise. Each bulb consists of an external part, which is vascular, and from which the hair derives its nourishment, and of an internal membranous part.

In some animals, hair is renewed once, but in others twice a-year.

Some have described the hair as consisting of an outer covering, and of an inner part, called the *Pith* or *Medulla.*

The horny covering is composed of numerous filaments placed laterally, which are of unequal lengths; those nearest the centre being the longest: hence the hair has somewhat of the form of an elongated cone, with its base in the skin; and on this property the process of felting depends.

According to some, the colour is resident in the horny covering; but, according to others, in the pith. The latter opinion is the more probable, as, in the spines of the porcupine, the pith is white, and the horny or outer covering white.

It has been doubted, whether hairs be composed of a congeries of smaller hairs united together, or of one hair which is tubular. What has been called the forking of hair favours the former opinion; whereas the structure of the whiskers of the seal favours the latter opinion. In the former there are two canals, and in the latter one distinct canal.

I have stated that the hairs are longest in animals that inhabit cold regions; and it is undoubtedly shorter in animals, as horses, that are kept in houses,—the heat seeming to retard the growth of the hair; but, on the other hand, heat promotes the growth of the beard.

The bulbs of the hair receive bloodvessels and nerves. The nervous filaments are very distinct in the inferior animals; and in the human body, at the roots of the eye-lashes, and at the roots of the hairs in the nostrils.

The hairs are in themselves insensible; but, on account of the large nerves distributed at their roots, they extend the organ of touch; hence the great use of whiskers to cats, and other animals that seek their prey at night; the slightest impression is communicated by the point of the whiskers to the nerves distributed at their base.

According to the experiments of Mr HATCHETT, hairs are composed of gelatine and coagulated albumen; and he has observed, that such hair as is softest and most flexible, and loses its curl in moist weather, most readily gives out albumen on boiling.

VAUQUELIN has stated there are two kinds of oil in hair; one of which varies with the colour of the hair: black hair yields black oil; the other is white.

In hair, sulphur, phosphate and carbonate of lime, iron, and manganese, are contained.

Of the Sixth Sense.

SPALLANZANI made a number of cruel experiments on bats, to prove the existence of a sixth sense. He plugged up their eyes, and destroyed their noses, ears, or mouths; then let them loose in a winding passage. He informs us they flew about without touching the sides of the passage.

Some of the German authors have endeavoured to prove that Man is also endowed with a sixth sense, which HUBNER has denominated *General Feeling*, or *Cœnesthesis*, and which is common to all the nerves of the body, excepting those of the five senses.

This sense, it has been said, communicates that internal corporeal feeling which creates a sense of lassitude or fatigue unconnected with muscular exertion or disease, or the more agreeable sensation of lightness or buoyancy. But it seems more probable, that such sensations are rather to be imputed to the state of nervous sensibility, than to an additional sense.

OF THE NERVES OF THE HEAD AND NECK.

In describing the senses of Smell, Vision, Hearing and Tasting, several of the nerves of the head have been already mentioned. Two of the great parts of the fifth pair yet remain to be described, the *Superior* and *Inferior Maxillary Nerves*.

It was stated, that a *ganglion*, or rather *plexus*, called GASSERIAN, was thrown across the fifth pair. As this remarkable pair has lately excited much attention, and as a

number of experiments have been lately performed upon it in London by Mr MAJENDIE, which afforded some very peculiar results, it may not be improper to give an account of a singular preparation in which this ganglion was much affected, and also of the symptoms which preceded the death of the patient. I am indebted for the preparation, and also for the history of the case, to Dr SANDERS.

" Serous effusion was copious on the surfaces of both cerebrum and cerebellum, in all the ventricles, and very copious in the cerebellic cavity of the skull. Cerebral substance unusually soft. On raising the cerebrum from before backwards, there appeared extending from the upper edge of the left *pars petrosa*, a mass separate from, but closely resembling the brain, or rather the cerebellum; it was minutely convoluted, and cineritious externally, and connected internally by ramifications from a medullary centre. It was pyriform; its round head, of about one three-fourths inch in diameter, pressed on the anterior surface of the tuber annulare, and had there formed a kind of glenoid cavity. On laying open the dura mater, the tumour seemed to be continuous with the Gasserian ganglion; which ganglion was hard, much enlarged, flattened, and somewhat oval; about one one-half inch long; three-fourths of an inch broad, and half an inch thick; its longest diameter was towards the *foramen lacerum*. The vessels composing the circle of Willis, and those immediately connected with it, were distended with dark blood, and the choroid plexus was very turgid, but of a dull red colour; and of this latter appearance was the net-work of vessels surrounding the crura cerebri, tuber, and medulla oblongata.

" The patient had, for months, been occasionally seized with headach, confusion of sight, and disorder of stomach, succeeded by vomiting. These attacks were ascribed to inebriation. At length he was struck with apoplexy. He was relieved by the usual means; his speech returned in some degree, but neither his vision, nor the power of volition, in the trunk and extremities. He had intervals, when the natural functions proceeded regularly; but always after two or three days, there suddenly came on palpitation, quick and irregu-

lar pulse, severe headach, pain and oppression about the præcordia, abdominal spasms, with bilious vomiting. In this way he lived from three to four months, when he died apoplectic.

"The phenomena, in this instance, seem to me to constitute the result of an experiment performed by the hand of Nature, in confutation of the principles assumed by the French physiologists, when they divided the nerves into those of animal, and those of organic life."

The second branch of the fifth pair, called the *Superior Maxillary Nerve*, passes through the foramen rotundum of the sphenoid bone, involved in the dura mater. Before leaving its proper canal it sends off a branch from its upper part, which communicates with the lacrymal branch of the first part of the fifth pair; and it sends a branch which passes in a canal above the antrum maxillare.; and, according to MECKEL, gives off two small nerves within the fossa pteryo-platina: these branches proceed towards the foramen spheno-palatinum, and form a *ganglion* somewhat of the figure of a heart, which is somewhat of a reddish colour, called, from its situation, the *spheno-palatine* by MECKEL, who has most particularly described it in the Memoirs of the Academy of Berlin for 1749.

From this ganglion, the superior nasal nerves, the vidian nerve, and the palatine nerves, take their origin.

The *Superior Nasal Nerves* are three or four in number: they are connected with the external surface of the ganglion; they perforate the dura mater which covers the foramen spheno-palatinum, and give small nerves to the back-part of the superior passage into the nose, and supply the ethmoidal cells.

The *Vidian* or *Pterygoid Nerve* is also connected with the back-part of the spheno-palatine ganglion.

This nerve enters the vidian canal: it gives very small filaments, which are spent upon the upper and back part of the nose, and are distributed upon the membrane that covers the back-part of the vomer.

The Vidian nerve takes a retrograde course, and enters the foramen innominatum of the pars petrosa of the temporal

bone, to join the portio dura of the seventh pair, in which course it gives off small nerves to the septum narium.

It merits mention, that the nerve is small in proportion to the size of the foramen innominatum, the greater part of which is filled up by the dura mater, and I have also observed a great variety as to the size of the foramen innominatum. When it is larger than usual, the meatus auditorius internus is proportionally smaller.

The other, or deeper-seated branch, which passes to the carotid canal, winds round the internal carotid artery, and unites with two or three small descending branches from the sixth pair of nerves, forms a very soft and intricate plexus. *This is the origin of the intercostal or great sympathetic nerve;* but upon this subject anatomists are by no means agreed.

According to Bock, the sympathetic nerve ascends from the cervical ganglion into the carotic canal, and then divides into an anterior and posterior branch, which anastomose by means of the soft ganglion of the sympathetic in the carotic canal, with the Vidian nerve, and with the third and sixth pairs of nerves.

Lobstein, who has devoted much attention to the subject, has described the origin of the sympathetic nerve as follows: "E nervo abducente tres ramulos vidi egredientes, retro euntes, seu cum continuato trunco nervi prædicti angulum formantes obtusum, arteriæ carotidi impositos, prope tertiam carotidis flexuram, plexum formantes gangliosum, rubicundum, cui filamentum a nervo vidiano accessit. Ex isto ganglio, præter surculorum mollium fasciculos duos, ad arteriæ tunicas duo potissimum exibant rami, unus retro carotidem, alter in ejusdem dorso incedens, qui, ubi ad imam canalis carotici sedem pervenerunt, in unum coibant funiculum gracilem, cui, nervi sympathetici nomen impositum est."

The next considerable branch which takes its rise from the spheno-palatine ganglion, is the *Palatine Nerve*, which arises from the lower part of the ganglion, and descends behind the corresponding artery through the foramen palatinum posterius.

During the progress of this nerve through the palatine canal, it gives off some small nerves, which are spent upon the lower and back part of the inferior concha of the nose, upon the back teeth of the upper-jaw, and upon the antrum maxillare; and after the trunk of the nerve has emerged from the palatine canal, it passes forwards under the membrane of the palate, upon which it divides into a number of small branches, which supply the soft palate, uvula, and tonsils.

After these nerves have been sent off, the part of the fifth pair enters the infra-orbitar canal, and has been therefore called *Infra-orbitar Nerve.*

This nerve gives off several small nerves, which are lodged in their proper canals, and which supply the teeth of the upper jaw. It next sends off a branch, called the infra-orbitar, which is spent upon the orbicularis palpebrarum muscle; and it gives also a few small twigs, which are spent upon the nose; and from the infra-orbitar nerve there are small nerves, which have been called the superior labial nerves, which communicate with the portio dura of the seventh pair.

The relation of the second branch of the fifth pair to the orbit merits the peculiar attention of the surgeon, as this nerve is to be divided immediately at its exit, in order to relieve that very painful affection of the face called Neuralgia faciei.

The division of the nerve should be made as closely as possible to the skull, as that nerve, soon after its exit, divides into a number of branches. In general the operation is only palliative, as the divided nerve is re-united by nervous matter.

The third great branch of the fifth pair of nerves, called the *Inferior Maxillary*, which is the largest branch, passes off at a right angle from the Gasserian *Ganglion;* it descends through the foramen ovale of the sphenoid bone, and passes under the internal pterygoid muscle; it gives off branches to the buccinator, pterygoid, and masseter muscles, and branches which accompany the superficial temporal artery.

The inferior maxillary nerve gives off a considerable branch, which, as it passes to the tongue, has been called the *Lingual Branch*, and which passes between the pterygoid muscles.

This lingual branch gives nerves to the sublingual gland, and the muscles of the tongue.

This lingual branch of the fifth pair then divides into five or six branches, which supply the point of the tongue, and terminate upon its papillæ; which have been very minutely and fully described by ALBINUS *.

The trunk of the inferior maxillary nerve sends off from its under part a *ganglion*, from which nerves are sent to the inferior maxillary gland.

Upon the peculiar distribution of this nerve my Grandfather has endeavoured to account for the convulsive contraction of the muscles of the lower jaw, the pain in the ear, great flow of saliva, and difficult deglutition, which accompany an irritation of the nerves of the teeth of the lower jaw.

There is a branch derived from the third part of the fifth pair, which descends between the condyle of the under jaw and the parotid gland; and it gives two or three small nerves to the meatus, and which pass outwards, and are distributed upon the external cartilage of the ear; and have been called, by HALLER, the *Auricular Nerves.*

The main trunk of the nerve passes between the pterygoid muscles, and then sinks into the foramen, between the condyloid and coronoid processes of the under-jaw. During the progress of the nerve through the canal of the under-jaw, it sends off several small nerves, which penetrate the substance of the bone, and also supply the teeth of the under-jaw. The nerve then emerges at the anterior mental hole, and is distributed upon the muscles of the fore-part of the chin.

Of the Seventh Pair of Nerves.

The origin of the seventh pair of nerves has been already described, and also the distribution of the part called the *Portio mollis*, upon the internal ear.

The course of the portio dura, across the internal ear, has also been described.

The portio dura passes through the foramen stylo-mastoi-

* Vide his Anat. Acad.

deum, and almost immediately divides into branches, which pass through the substance of the parotid gland; and as the distribution of these branches resembles, in form, a goose's foot, anatomists have made mention of the *Pes anserinus*, which is divided into four principal fasciculi. The uppermost may be called the *Temporal*, as the nerves are distributed upon the temporal; the second the *Superior Maxillary*, as the branches are spent upon the parts connected with the upper-jaw; the third and fourth the *Inferior Maxillary*, and *Cervical*, for a similar reason.

Professor Meckel has described and represented these several fasciculi of nerves with very great minuteness, and to his accurate description I beg leave to refer the reader; as also to the engravings of Mr Swan and Mr C. Bell *.

The branches of the portio dura unite with the second and third branches of the fifth pair. My Father, in making mention of the conjunction of these nerves, has observed †: "The most remarkable connection of this kind is in the human face, where the portio dura, of the auditory nerve is joined to the second and third branches of the fifth pair of nerves. Many of these nerves joined are so small, that it is difficult to trace the fibrils of which they consist; but, in the larger branches, both in man and in the ox, I have certainly found, that the smaller branches, which come off beyond the union of two larger nerves, consist of fibres from both."

Some of the branches of the *temporal fasciculus* run over, and others under, the branches of the temporal artery, and unite with the frontal branches of the fifth pair.

The branches of the *superior maxillary fasciculus* communicate with the first and second branches of the fifth pair, of which my Father has published an engraving.

The branches of the *inferior maxillary fasciculus* advance along the under-jaw, and are dispersed upon the muscles proper to it and the upper-lip; they are connected with some of the branches of the superior maxillary fasciculus, and also with branches of the third part of the fifth pair.

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* Phil. Trans. † Vide Nervous System, p. 48.

The *cervical fasciculus* pass beneath the under-jaw; some of the branches run near to the external jugular vein, to the platysma myoides, and skin of the neck; and they communicate with the uppermost cervical nerves.

On account of the union of the portio dura with the branches of the fifth pair of nerves, Mr C. Bell has endeavoured to prove, that these nerves perform different offices. He divided the portio dura of one side, when the animal was panting, and forcibly dilating its nostrils. *The motion of the nostril of the same side instantly ceased*, whilst the other parts of the respiratory organs were excited, and while the opposite side and nostril acted in unison with the chest.

When the portio dura of one side was cut, and ammonia presented to the nose, the same side remained quite relaxed; and the other was curled up, with the peculiar expression of sneezing.

The slightest touch on the portio dura convulsed the muscles of the face, but caused no pain. The reverse was the case with the fifth; touching it gave great pain; but there was more difficulty in exciting the muscles.

The observations of Mr Mayo *, and the following case, which occurred to Mr Wallace, do not accord with the experiments of Mr Bell.

"Some years ago †," says he, "there occurred to me, during my dissections, a very unusual arrangement of the nerves of the face. All that part of the facial of the right side, which is distributed to the side of the face and temples was wanting, and its place supplied by a trunk from the second division of the trifacial; which trunk turned round the posterior edge of the ramus of the jaw, and emerged through the parotid, having an appearance extremely like the facial, in ordinary circumstances. I had fortunately known the individual, when alive, and there was not any thing remarkable in the expression of his countenance. The conclusion to which I was, of course, irresistibly led, by this lusus was, that *these nerves*

* Anat. and Physiol. Com. No. I. London, 1822.

† Vide Quarterly Medical Journal, No. xxiv. p. 301. for April 1822.

must be possessed of exactly the same properties and structure, or the one could not supply the place of the other. Such an opinion was also, on consideration, greatly supported by the well known similarity of arrangement, and intimacy of connection, which these nerves have, in their natural distribution."

Of the Eighth Pair of Nerves.

The eighth pair of nerves is connected, by several small nerves, with the basis of the corpora olivaria. It consists of two parts; of the par vagum, or pneumo-gastric nerve, and of the glosso-pharyngeus; which latter has been already described.

The par vagum, or pneumo-gastric nerve, is composed of several small fasciculi, which are collected into a single trunk, which passes through the foramen lacerum in basi cranii, before the lateral sinus; from which latter it is separated by a process of the dura mater. After the par vagum has passed through the skull, it is somewhat enlarged, forming a sort of *ganglion.*

The par vagum descends, in the neck, in the same cellular sheath with the internal jugular vein, and common carotid artery.

In the horse, this nerve is of great size, and larger, in proportion to the sympathetic nerve, than in man.

The branches of the par vagum are, 1*st*, the *Pharyngeal Branch*, which receives branches from the accessory nerve, and from the glosso-pharyngeal nerve.

The pharyngeal branch sends off several small nerves, which unite with others, from the great sympathetic nerve, which pass along the common carotid artery.

The other branches of the pharyngeal nerve are distributed upon the middle and back part of the constrictors of the pharynx; and these unite with some small filaments of the glosso-pharyngeus, and also with the superior laryngeal nerve, and with the accessory nerve, and sympathetic.

My colleague Dr Home had a patient afflicted by the usual symptoms of stricture at the cardia, and in addition to these, whenever she turned to the left side, she suffered very

much from acute pricking pain, in her neck. She died in the course of three months, very much emaciated.

Dr Home requested of me to examine the body, in order to ascertain, whether there were any morbid appearances which could account for the acute pricking pain, with which the patient had been so long affected. I did so, and found a very considerable enlargement of the par vagum on each side of the gullet, which extended as low down as the cardiac orifice of the stomach, which was encircled by a scirrhous tumour.

2d, The *Superior Laryngeal Branch* descends between the pharynx and carotid artery, and divides into an external and internal branch; the former of which joins with the intercostal nerve. The interior branch creeps along the margin of the thyroid cartilage, and its branches are distributed upon the epiglottis, the membrane of the pharynx, the arytenoid muscles, and arytenoid gland. The exterior branch, called by Scarpa the *Pharyngo-laryngeal*, anastomoses with a ganglion of the sympathetic; and from this junction of nerves small branches are sent, which supply the constrictor muscles: it ultimately terminates upon the thyroid gland, and the mucous membrane which lines the larynx.

The laryngeal nerve not only adheres to the *olivary* ganglion of the great sympathetic nerve by cellular substance, but also receives a soft and nervous matter from the above named ganglion.

That the sound of the voice is very much influenced by the nerves, is a fact universally admitted; but it remains yet to be ascertained, whether it depends chiefly upon the recurrent branch of the eighth pair, or upon the laryngeal nerve. Most authors are of opinion, that it depends chiefly upon the former; but, in my opinion, it depends also, to a certain extent, upon the latter nerve, the laryngeal.

The pressure and irritation of tumours upon the eighth pair of nerves, produces a remarkable loss as to the strength of the voice. This circumstance may be observed to happen from an aneurism of the arch of the aorta, or from the same disease of the carotid artery, or from an enlargement of the

thyroid gland. I was consulted lately by a woman of sixty years of age, who had laboured under the last named disease for fourteen years. Her voice was so weak that I scarcely could hear what she said, and at the same time husky; and, to make use of her own phrase, she had "lost her voice ever since her throat swelled."

That the strength of the voice is much impaired by irritating or dividing the par vagum of the eighth pair of nerves has been long known. My Grandfather has stated, that from the distribution of the par vagum we may learn how the nervous asthma and tussis convulsiva are attended with a straitening of the glottis.

An experiment was made two years ago, in the Anatomical Theatre, upon a large dog, which illustrated several important circumstances, resulting from the division of the eighth pair of nerves.

The eighth pair of nerves on the right side was divided opposite to the thyroid cartilage of the larynx, (February 15. 1822), upon whicch the animal became very much agitated, and shook from head to foot for several hours. The under eye-lid of the same side was turned outwards, and became what is commonly called bloodshot.

The opposite extremities of the divided nerve were turned in different directions, after which the wound was slightly dressed.

After the operation, the dog was evidently feverish, and refused every kind of food that was offered to him.

He attempted to drink water frequently, but he could not readily swallow it; it gurgled for some time in his throat, as in cases of dysphagia, and at length a part of it got down.

After forty-eight hours, he took some boiled beef, the greater part of which was rejected by vomiting, and this continued during four days, when he seemed hungry, and took some animal food, which he retained.

He lost entirely the power of barking, and could make only a noise somewhat like to that of a puppy two or three weeks old. It merits mention that there was an appearance of a third eye-lid. The dog on the sixth day from the ex-

periment seemed in good health, but was extremely thirsty, and drank a great deal of water: he passed little by stool, and only after a considerable effort. Six weeks after the first experiment had been performed, the eighth pair of the left side was divided by my assistant opposite to the thyroid cartilage, who assured me, that he not only divided but also cut out an inch and a half of the nerve. The result was somewhat similar to that of the preceding experiment.

The dog rejected every kind of food; on the third day, he seemed somewhat better, but still trembled very much. The eye of the left side was affected as that of the right side; he was extremely thirsty, and drank a great deal of water, but passed very little by stool; and in this state he continued for twelve days after the nerve had been divided and cut out. He became considerably emaciated, but could run about.

In the first experiment, I apprehended that the power of swallowing and of retaining food in his stomach, indicated the moment when a reunion of the divided par vagum had taken place.

"*April* 12. The dog is now much more lively, and can retain the food he takes better, provided he is not allowed to drink water, which he always does in great quantity. He can now make as it were an approach to a bark. Still has a degree of tremor upon him.

"*April* 17. Dog is now much stronger; his voice, when he attempts to bark, is louder, but he cannot emit a sound like other dogs in barking. He now retains solid food, but if he drinks even a cupful of water, he instantly vomits. Has now passage in his bowels every day."

The dog continued to linger on, becoming gradually more and more emaciated, until the 20th May, when he died. From the result of this experiment, it is obvious, that the sound of the voice depends chiefly upon the recurrent nerve; for the eighth pair was divided below the superior-laryngeal nerve; and this fact was rendered so obvious by this experiment, that I did not think it necessary to repeat it.

On examining the appearances after death, I found that the divided portions of the left par vagum had retracted from each other, and that the opposite ends were united by a slender cord, which was like a nerve in colour and texture. The carotid artery was obliterated for two inches. On the right side, about one inch and three quarters had been cut out; there was an evident enlargement at the divided extremities, and there was the formation of a new cord, which reunited the divided portions of the nerve; and this cord in all respects to the eye resembled a nerve, for I did not wish to destroy the preparation, by trying the effects of an acid or solution of an alkali upon it, as the new formation of nervous substance, when a nerve has been divided, has been sufficiently proved by the experiments of Mr CRUICKSHANK, Dr HAIGHTON, MAYER and other authors.

I made also four different experiments upon the sympathetic nerve, with the view of determining its influence upon the sound of the voice, and upon the functions of the animal economy. In some of the experiments, a portion of the nerve on one side was removed, and in others considerably more than an inch of both sympathetic nerves were cut out.

Exper. 1. *July* 5. The sympathetic nerve of the left side of a rabbit was divided about half an inch above the first rib, and an inch of it was cut. The animal was immediately seized with a tremulous motion all over the body. Soon afterwards it could readily run about, from place to place; and about an hour after the experiment ate a good deal of clover.

July 8. The wound made has now nearly healed; the animal runs about freely, eats a good deal, and dungs also.

July 10. The wound is now completely cicatrized. The animal runs about with great vigour, and seems in perfect health.

Exper. 2. *July* 6. About an inch of the sympathetic nerve of another rabbit, on each side of the neck, was cut out.

The animal did not scream aloud. The wound made was accurately sewed up. After the operation, the animal ran about.

July 8. Now a good deal of dung in the place where the animal was kept. The rabbit has eaten a good deal, and seems in health.

July 13. The animal seems in all respects healthy.

Exper. 3. *July* 10. The same experiment was made on a third rabbit as on the preceding, and the result was quite similar this day. *N. B.*—The cellular substance was dissected from the par vagum.

July 11. The animal seems in perfect health, has eaten a good deal of clover and cabbage leaves, and has passed a good deal of dung.

July 14. The animal seems in all respects well. The wound has healed by the first intention.

August 30. This rabbit had young four weeks ago.

Mr Petit informs us in the History of the Acad. des Sciences for 1727, that he made many experiments on living dogs. He cut the intercostal nerve opposite to the third or fourth vertebra of the neck. He adds, that as the intercostal nerve is in the same sheath with the eighth pair, the one nerve cannot be cut without the other. The result of dividing the eighth and sympathetic nerves, was an affection of the eyes, the animal's difficult breathing, and palpitation.

But it has been proved by many experiments, that the symptoms above enumerated are owing solely to the division of the eighth pair, for they are not occasioned when the sympathetic nerve only is divided. It is difficult to explain why the muscles of the eye should be so much affected by the division of the eighth pair, as the nerves of the muscles which move the eye-ball are not connected with the nerves distributed on the muscles of the orbit.

Dr Portal of Paris, in the fourth volume of his Anat. Med., informs us, that the eyes are much affected by divid-

ing the sympathetic nerve. But this did not seem to be the case in any of the experiments which I performed.

Exper. 4. *August* 29. About one-half inch of the sympathetic nerve of the left side of a fourth rabbit was cut out, and on the right side a similar portion of the sympathetic nerve, and about an inch of the phrenic nerve.

As soon as the wound was sewed up, the animal ran about very vigorously, and did not betray a single symptom of having been injured in any way.

A case, in which a tumour, surrounding the windpipe, was cut out by KLEIN of Germany, shews clearly the effect of dividing the eighth pair of nerves. In consequence of the operation the patient remained speechless for three weeks, and his voice became "a deep well-toned bass."

Of the Recurrent Nerve.

The eighth pair sends off a nerve which is reflected backwards, and has been hence called *The Recurrent;* it bends around the right subclavian artery, and on the left side around the aorta.

This nerve ascends, and adheres to the posterior and lateral parts of the windpipe, in its progress to the larynx, and behind the thyroid gland; it sends off very minute nerves, which penetrate the windpipe, and are distributed upon its internal membrane; and also some small nerves, which are spent upon the thyroid gland.

On the inner side of the thyroid cartilage, a branch is sent off from the recurrent nerve, which communicates with the internal laryngeal nerve; and from this branch of the recurrent, very minute branches penetrate deep, and are spent upon the internal mucous membrane of the larynx.

The recurrent nerve, as has been very faithfully represented by SCARPA in his Table III. of the nerves of the head, neck, and thorax, is connected with the sympathetic nerve, with which it forms an intricate plexus of nerves, from which nerves descend, and are distributed upon the bronchi and pulmonary artery.

Galen, Vesalius, Bidloo, Morgagni, and others, have affirmed, that, if the recurrent nerves are cut, the voice is entirely lost. But as the larynx receives a pair of superior laryngeal, as well as recurrent nerves, my Grandfather suspected that such experiments had not been made with sufficient accuracy. In 1752, my Father ascertained that this was really the case; for, at that time, assisted by the ingenious Dr Emmett, he cut those nerves in a small dog, and observed, that, although the voice of the animal was very sensibly altered in tone, and weakened, yet it was far from being lost; nay, in the course of six weeks, the strength of the voice was in a considerable degree restored. Hence, there was reason to conclude, that each of the muscles received branches from the superior laryngeal nerves. "Since that time (he adds) I have found, on dissecting the nerves of the human larynx, that the recurrent and superior laryngeal nerves are joined together by their apices, or that they form a plexus, resembling that of the nerves of the face; and that, from both nerves, each muscle of the larynx receives branches."

Of the Ninth Pair of Nerves.

The ninth pair has been already described, with the exception of that nerve called the *Descendens Noni*. The ninth pair, in its descent, winds round the external carotid artery, just below the rise of the occipital artery; and, at this place, the descendens noni takes its rise. This branch descends along the common carotid artery, rather more than mid-way between the os hyoides and breast-bone, and it unites with small branches of the first, second, and third cervical nerves; and, after this junction, small nerves are sent to the upper part of the sterno-hyoid and sterno-thyroid muscles. The descendens noni may be injured by a surgeon in performing the operation for the carotid aneurism, as it lies in front of the tumour.

Of the Sympathetic Nerve.

The origin of this nerve has been already described.

After the sympathetic nerve has emerged from the carotid canal, it receives branches from the first, second, and third cervical nerves; and it is joined with the eighth and ninth pairs of nerves.

After this union of nerves, the sympathetic nerves swell out into a large ganglion, opposite to the second vertebra of the neck. This ganglion is somewhat like to an olive in form, and hence called *Olivary*. It has been particularly described and represented by my Father, in Plate 21. of his Nervous System.

This ganglion varies in size, in different individuals, and sometimes, according to LOBSTEIN, it is double. This ganglion is connected with the root of the sub-occipital nerve, and there are small filaments which descend from it behind the internal carotid artery.

There are branches which, uniting with nerves from the superior laryngeal, form the superficial nerves of the heart.

Branches from the second, third, and fourth cervical nerves pass downwards, behind the scaleni muscles, to this ganglion; and there are nerves from this ganglion which are united to the recurrent branch of the eighth pair.

Other branches from this ganglion pass behind the subclavian artery, and join with the inferior cervical and uppermost ganglion of the thorax.

The trunk of the sympathetic nerve, which is much contracted, and almost round, descends behind the carotid artery and the eighth pair of nerves, along the longus colli muscle, becoming gradually smaller, though it receives several branches from the 8th pair, and from the 5th and 6th cervical nerves. Where the thyroid artery passes to the thyroid gland; or upon the fifth and sixth cervical vertebra, the middle ganglion of this nerve is placed; and there are some instances in which this ganglion is awanting. From this ganglion branches are sent to the heart, which anastomose with branches of the recurrent, from which a plexus of nerves is sent to the aorta, to the pericardium and to the heart, and these accompany the coronary artery to the point of the heart.

From the ganglia of the sympathetic nerve, small nerves are derived, which creep along the trunks of the subclavian artery and aorta, to the heart. When the sympathetic nerve has reached the chest, it becomes larger.

Of the Accessory Nerves.

The accessory nerves arise from the sides of the medulla oblongata, and spinal marrow, and pass out at the foramina lacera in basi cranii, along with the par vagum of the eighth pair. These nerves are connected by filaments to the posterior bundles of some of the spinal nerves.

The accessory nerves are then detached from the eighth pair, perforate the sterno-mastoid muscles, and terminate on the trapezius muscle. There is a branch of this nerve which is sent off before it perforates the sterno-mastoid muscle, which assists in forming the pharyngeal nerve.

Of the Spinal Cord.

The spinal marrow, or spinal cord, is lodged within, and defended by, the bony canal, formed by the conjunction of the vertebræ of the back. It extends from the medulla oblongata of the brain to the second vertebra of the loins, as a solid cord, where it terminates in a conical point.

The spinal cord is not of an uniform size; it is sensibly smaller where it passes through the vertebræ of the back, than where it passes through the cervical or lumbar vertebræ; and, as it follows the same course as the spine, is not straight.

The younger the embryo the greater the proportion the spinal cord bears to the brain; and, according to Serres, the spinal cord and corpora quadrigemina of the brain bear a direct ratio to each other.

The spinal cord, like the brain, is covered by the *dura mater*, the *arachnoid coat*, and *pia mater*. From its sides nerves in pairs are derived, which pass through foramina common to two vertebræ, and through the foramina of the os sacrum.

The arachnoid coat is closely connected with the pia mater by cellular substance; and its outer part is connected with the dura mater between each pair of its nerves, by sharp-pointed membranes, resembling the teeth of a saw, which are said to form a *ligamentum denticulatum.*

The spinal marrow is flattened before and behind with transverse folds on it; and, in the middle of the spinal cord, *there is a distinct canal or groove;* so that it seems to be composed of two cords, each of which is subdivided, and consists, like the brain, of cineritious as well as of medullary matter, but the former is *internal;* and hence, upon dividing transversely the spinal marrow, its internal cineritious substance has a cruciform appearance.

It has been stated by GALL, that the grey matter is formed before the white; but this does not hold true in respect to the spinal cord. This has been observed during the incubation of the chick; for the rudiment of the spinal cord is, at that period, formed of white matter only; the grey matter is a subsequent addition. It may be also observed, that the very minute examinations of the embryo by the WENZELS, TIEDEMANN, and SERRES, have given additional weight to the opinion of my Father, as to the grey and white matter of the brain, viz. that the grey is the original matter, and gives origin to the white substance of the brain. The thalamus nervi and corpus striatum of the embryo, are composed of grey matter only; and the streaks of white matter afterwards observed in the corpus striatum are not yet formed. The streaks in the parietes of the fourth ventricle are not visible until fifteen or eighteen months after birth.

Every nerve derived from the spinal marrow consists of an anterior and posterior bundle of nervous fibres, each of which has its proper hole in the spinal canal, on the outer side of which they are involved in a common sheath; and, when this has been dissected with care, a ganglion is discovered in the posterior bundle.

Mr C. BELL has discovered, that the anterior and posterior bundles of nervous fibres differ in function: on the

former, the power of motion depends; and, on the latter, sensibility. He concluded, that the brain and smaller brain, "were parts distinct in function, and that every nerve, possessing a double function, obtained that, by having a double root." He adds, "Such nerves as are single in their origin from the spinal mrrrow, will be found either to unite in their course with some other nerves, or to be such as are acknowledged to be peculiar in their operation." The opinion of Mr Bell has been confirmed by the subsequent experiments of Majendie.

Dr Bellingeri of Turin, lately made experiments on the nerves of the spine of sheep and horses. He states, that the posterior roots of the lumbar and sacral nerves communicate the power of extension in quadrupeds; the anterior roots of the same nerves, on the contrary, give rise only to the power of flexion. The posterior roots alone preside over the sense of touch.

The white substance of the spinal cord, and nervous filaments arising therefrom, are destined for movement; the grey matter, on the contrary, and the nerves arising from it, are the organs of touch *.

The nerves connected with the spinal marrow pass off at more acute angles, as we trace them downwards to the lower end of the spinal marrow. The nervous filaments below the termination of the spinal marrow as a single cord, or lower than the second lumbar vertebra, are disposed in a parallel manner in respect to each other, and somewhat like the hairs in a horse's tail; hence that portion of the spinal marrow has been called *cauda equina*.

The posterior branches of the spinal marrow in the neck are connected to each other by smaller nerves.

On the outside of the dura mater, the spinal nerves are connected on their fore part to a nerve called the *great sympa-*

* Vide a more full description of the spinal marrow, in my Father's Treatise on the Nervous System, p. 28, 29. &c.

Vide also Tab. x., affixed to the Nervous System.

thetic nerve, and joined to each other by large arches, from which the muscles of the head, trunk, and extremities, are successively supplied. Hence the heart, lungs, stomach, and other organs, on which life must immediately depend, and on which the branches of the sympathetic nerve are distributed, are not on account of the sympathetic nerve being connected with the brain, as well as with the spinal cord, in less danger of being deprived of the nervous influence than the muscles of the limbs, the organs of voluntary motion, which receive their nerves only from the nerves connected with the spinal cord.

The spinal cord has been thought by some anatomists, to be the prolongation of the brain and cerebellum; but my Father found, in a monster born without a head, the spinal cord and nerves connected with it, as large as in a perfect child; so that it is independent of the brain.

Bloodvessels of the Spinal Marrow.

The bloodvessels of the spinal marrow are derived from the vertebral, intercostal, and lumbar arteries.

The anterior spinal arteries take their rise from the vertebral arteries; descend along the whole of the anterior surface of the spinal marrow, and in the neck anastomose with the thyroid and cervical arteries, and in the back with the intercostal and lumbar arteries.

The posterior and smaller arteries of the spinal marrow are derived from the inferior cervical arteries of the cerebellum, or from the trunks of the vertebral arteries within the skull.

These arteries of the spinal marrow are subdivided into very small branches, which are distributed upon the medulla and its membranes *.

The veins of the spinal marrow accompany the arteries, and end in the venous sinuses of the spine, which extend from the foramen magnum of the os occipitis, to the under end of the os sacrum, and are lodged in the ligamentous membrane, which lines the vertebral canal; and the blood from these ve-

* Vide London Med. and Phys. Journal, July 1821, page 15.

nous sinuses flows into the smaller branches of the vena azygos.

The spinal cord exists in all classes of animals before the brain. It consists at first of two lateral cords, which are disunited behind.

The interior of the cord is hollow, and has sometimes been filled by a fluid.

This canal is obliterated in the human embryo at the fifth month, by the successive deposition of a grey substance, which is probably secreted by the pia mater lining the canal.

According to SERRES, the development of the tuberosities of the spinal cord correspond with the limbs. Those animals that have only one pair of limbs, have only one tuberosity, as the *Cetacea;* and the position of the tuberosity varies according to the position of the limbs, in respect to the trunk of the body. The genus *Bipes* has its tuberosity on the posterior part of the spinal cord; and the genus *Bimares* on the anterior part.

Lastly, SERRES has also stated, that the spinal cord is not protuberant at the origin of each particular nerve, as GALL and SPURZHEIM have affirmed, to which first opinion I subscribe.

Dr WILSON PHILIP, in his celebrated book on the Vital Functions, has drawn the following conclusions.

"1. That the cause of all the motions of inspiration has its seat near that part of the medulla oblongata which gives rise to the nerves of the eighth pair.

"2. That the cause which animates each part of the body, resides in the part of the spinal marrow from which the nerves of that part are derived.

"3. That, in like manner, it is from the spinal marrow that the heart derives its life and its powers; but, from the whole spinal marrow, and not merely from any particular part of it.

"4. That the great sympathetic nerve takes its rise from the spinal marrow, and that the particular character of that nerve is to bring every part to which it is distributed, under the immediate influence of the whole nervous power.

"5. That the brain and spinal marrow act, each of them, di-

rectly on the heart as well as on the muscles of voluntary motion.

" 6. That the laws which regulate the effects of stimuli applied to the brain and spinal marrow on the heart and muscles of voluntary motion are different.

" 7. That mechanical stimuli applied to the brain and spinal marrow, are better fitted to excite the muscles of voluntary motion, and chemical stimuli the heart.

" 8. That neither mechanical nor chemical stimuli, applied to the brain and spinal marrow, excite the muscles of voluntary motion, unless they are applied near to the origin of their nerves; and, consequently, that these muscles are excited by stimuli applied to very minute parts of the above organs.

" 9. That both mechanical and chemical stimuli, applied to any considerable part of the brain or spinal marrow, increase the action of the heart, which cannot be increased by any stimulus applied to a minute part of these organs.

" 10. That the heart obeys a much less powerful stimulus applied to the brain and spinal marrow, than the muscles of voluntary motion do.

" 11. That stimuli applied to the brain and spinal marrow, excite irregular action in the muscles of voluntary motion.

" 12. That no stimulus applied to the brain or spinal marrow, excites irregular action in the heart or vessels of circulation, nor is their action rendered irregular by sedatives, unless a blow, which crushes a considerable part of the brain or spinal marrow, be regarded as a sedative.

" 13. That the excitement of the muscles of voluntary motion, takes place chiefly at the moment at which the stimulus is applied to the brain and spinal marrow, while that of the heart may generally be perceived as long as the stimulus is applied.

" 14. That after all stimuli applied to the brain and spinal marrow, fail to excite the muscles of voluntary motion, both mechanical and chemical stimuli so applied still excite the heart.

" 15. That all the foregoing differences in the effects of stimuli applied to the brain and spinal marrow on the heart and

muscles of voluntary motion, are referable to the following law: that the heart is excited by all stimuli applied to any considerable part of the brain or spinal marrow, while the muscles of voluntary motion are only excited by intense stimuli applied to certain small parts of these organs."

The spinal cord is liable to be injured by an unnatural contraction of the spinal canal, by distortion, fracture, subluxation or dislocation (according to some authors) of the vertebræ, or by caries of these bones. Much useful information respecting spinal diseases has been lately communicated to the public, by Ramchetti, Brera, Abercrombie, C. Bell, Shaw, Bampfield, Ward and Olivier. The spinal cord is liable to suffer from concussion, and also from peculiar derangements.

1*st*, It is liable to suffer from *concussion*. Many instances have occurred, in which persons, after the receipt of a very slight injury upon the back, which did not break, or even discolour the skin, have suddenly been deprived of the use of the inferior extremities, and of the power of voiding their urine; and if the upper part of the spine be injured, there is difficult breathing, accompanied by a loss of power of the superior extremities.

Upon dissection, no morbid appearance is discovered.

Inflammation of the brain is sometimes a consequence of concussion of that organ; the same holds true in respect to the spinal cord. It is also liable to a turgescence of the bloodvessels proper to it, and which is a very frequent concomitant of convulsive disorders; and so much so, that when we find a portion of the intestines of a child very much contracted after death, we may be assured, upon opening the spinal canal, of finding its bloodvessels, and more especially its veins, very much distended by blood, and following a tortuous course.

This appearance is often combined with the effusion of a gelatinous substance between the coats of the spinal cord. The symptoms which precede death, originating from such a cause, are tremors, chorea, epilepsy and palsy.

The most striking case of inflammation of the brain and

membranes of the spinal cord which I have seen, was that of a person who had laboured under tetanus for several days.

In consequence of inflammation, purulent matter is often found between the spinal cord and its membrane.

There is also sometimes a serous effusion between the membranes of the spinal cord.

Several instances have been described, of a loss of a part of the spinal cord, by DESAULT *, COPLAND, RULLIER † and OLIVIER ‡.

What is remarkable, one of the patients retained the feeling and power of motion of the inferior extremities; and, in a similar case related by BAYLE, the patient was afflicted by frequent lancinating pain.

Of the Nerves of the Neck.

The sub-occipital nerves take their rise from the beginning of the spinal marrow, by an anterior and posterior fasciculus.

These nerves perforate the dura mater under the entrance of the vertebral artery, and pass over the transverse process of the atlas.

These nerves, after their exit from the spinal canal, are connected with the ninth pair, and with the first cervical nerve; and their branches are distributed upon the recti and oblique muscles of the head; and before, they are connected by two or three small filaments from the uppermost ganglion of the sympathetic nerve.

The FIRST CERVICAL NERVE passes out between the first and second vertebra of the neck, and divides into two large branches. *The one* is spent on the extensor muscles of the head and neck, and then ascends upon the occiput, dividing into many branches, which are distributed upon the back-part of the head. *The other branch* is united with the accessory nerve, the ninth pair of nerves, and uppermost ganglion of the sympathetic nerve, from which a nerve is sent downwards to the second cervical ganglion.

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* Journal de Chirurg. tom. iv. † MAJENDIE's Journal, July 1823.

‡ De la Moelle, Ephimer. Paris, 1824.

The SECOND CERVICAL NERVE, after passing between the vertebræ, is united to the middle ganglion of the sympathetic nerve, and also to the third cervical nerve.

From this nerve a small filament passes, to form the beginning of the phrenic nerve.

A considerable branch of this nerve emerges from behind the sterno-mastoid, after having passed around that muscle, divides into the following branches: a branch which passes downward along the jugular vein; a branch which assists in forming the phrenic nerve; a branch which divides into many branches, viz. the *inferior cutaneous nerve*, which supplies the parts of the lower jaw; the *middle cutaneous nerve*, which supplies the parts around the angle of the jaw; and a branch which supplies the back-part of the ear, called *posterior auricular*, and which subdivides into branches, which are distributed on the back-part of the ear and temple, the platysma muscle, the parotid gland, and which communicate with the portio dura of the seventh pair.

The continuation of the second cervical nerve is spent upon the extensor muscles of the head and neck, and the levator scapulæ.

The THIRD CERVICAL NERVE joins with the middle ganglion of the sympathetic nerve, with the trunk of the fourth cervical nerve, and assists in forming the *phrenic nerve.*

A branch of this nerve joins with the middle ganglion of the sympathetic nerve, and also with the descending branch of the ninth pair, which has been well represented by BANG.

This nerve afterwards divides into *external* and *internal branches;* the former supplies the upper part of the scapula, the latter supplies the muscles and skin at the upper part of the neck and shoulder.

The FOURTH CERVICAL sends branches to the middle ganglion of the sympathetic nerve, to the deep muscles of the neck, glands of the neck, and is connected to the phrenic nerve, and to the fifth cervical nerve.

This nerve sends branches, which are spent upon the anterior scalenus and trapezius muscles; and upon the latter muscle it communicates with the accessory nerve.

The FIFTH CERVICAL NERVE is joined to the fourth and to the sixth cervical.

The SIXTH CERVICAL is considerably larger than the preceding, and joins the SEVENTH CERVICAL NERVE behind the clavicle.

Mr S. COOPER has remarked *, that one of the cervical nerves may be mistaken for the subclavian artery, in consequence of the pulsation being communicated to all the adjacent parts. I have seen a mistake of this kind actually made by very skilful surgeons.

The three inferior cervical and first dorsal nerves pass between the scalenus anticus and medius muscles, and then under the snbclavian muscle to the axilla, where they form the *axillary plexus of nerves.*

In the axillary plexus of nerves, there is a very intimate intermixture of nervous threads †, which surrounds the axillary artery and vein.

The long continued pressure of crutches upon the axillary plexus sometimes creates a shrinking of the arm.

On account of the vicinity of the lymphatic glands of the axilla to the axillary plexus of nerves, it is obvious that great caution is requisite in the extirpation of these glands.

The complete division of the axillary nerves is not so dangerous as the application of a ligature to a nerve. In illustration of this remark, it may be added, that I had occasion

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* First Lines of the Practice of Surgery, 4th edit., vol. i. page 319.

† Vide representations of the axillary nerves in my Father's book on the Nervous System, Tab. xv. & xvi.

"Every nerve," says my Father, "of the spinal marrow is joined near to its exit by an arch, with the nerve above and below it; but the connection of the several nerves of the arm, or of the leg, may be considered as chief examples of plexus."

"Many years ago, I was at the pains of tracing the fibres of the nerves of the arm, from their origin in the spinal marrow to their termination in the parts of the arm, by slitting open the sheaths of all the trunks where they form the brachial plexus. I found, indeed, as I expected, that, in the plexuses, the fibres of the different trunks were intermixed, and that every nerve under the plexus consisted of fibres of all the nerves, which were tied together above its origin from the plexus."

to visit a man whose arm had been torn off by a wheel. The patient survived three days, during which he did not suffer from any of the symptoms of nervous agitation. He did not lose above two ounces of blood.

His death was owing to a very violent inflammation of the chest, in consequence of injury done to it.

The axillary nerves, upon dissection, were found considerably inflamed and thickened, and the different nerves adhered to each other, and the torn extremities were rounded.

Mr Cheselden has made particular mention of the case of a man whose arm was torn off. He observes, " The vessels being thus stretched, bled very little; the arteries and nerves were drawn out of the arm. The patient had no severe symptoms, and the wound was cured by superficial dressing only."

Dr Hennen, in his valuable work on Military Surgery, has published a very interesting case, which illustrates very strongly the effect of ligatures upon the axillary plexus, after they had been divided. He has stated,

" The first attempt at clearing the ligatures, and making gentle pressure on them, was attended with pain so excruciating, as to leave no doubt that each included a nerve, or was in a certain degree connected with some large nervous filaments. This agonizing sensation was not felt except the ligatures were pulled at, and then not in the stump itself, but referred to the finger, thumb, wrist, elbow, or even to the external skin of the lost arm, as one or other ligature might be handled. I have sometimes been led to think, that the General uniformly felt the same sensations when the same ligature was touched, as I generally made my attempts to extricate them in a regulated succession, and his complaints were often of the same succession of parts. More attentive observation, however, convinced me that this was not the case; for, if any one was pulled with more steadiness than another, he complained of all the parts suffering pain simultaneously. One small ligature, if pulled in an oblique direction *inwards* towards the axilla, always gave him imaginary pain about the elbow, or in the skin; but, if the same was pulled directly

downwards, the fingers were complained of. He has frequently, after the smarting of dressing was over, with great accuracy, pointed out on my arm the course of the internal cutaneous nerve, as the site of his ideal pain; often he has described that of the external; and, on one occasion, I, with utter astonishment, had the general neurology of my arm and fingers traced by him. But unless the ligatures were pulled at, he had no other uneasy sensations than those which usually occur in persons whose limbs have been amputated. Once only did I ever know him refer his pain to the seat of the sensorium itself. On that occasion, from using an artery forceps to the ligatures, on which the slide moved rather stiffly, I exerted a greater force than I had intended. He convulsively put his hand to his head, expressed a sense of exquisite pain in his brain, involuntary tears dropped from his eyes, a paralytic contraction momentarily affected his mouth, an universal paleness spread over the uncovered parts of his body; and, although unusually tolerant of pain, and of a most remarkable equanimity of temper, he uttered a piercing cry, and exclaimed, "that the agony in his head and neck was insufferable."

The following nerves are derived from the axillary plexus:

1. A NUMBER OF SMALL NERVES to the subscapulary, teres major, and latissimus dorsi muscles.

2. The EXTERNAL THORACIC NERVES, which accompany the external thoracic arteries to the pectoral muscles, mammæ, and skin over these.

Dr MASON GOOD*, has described, at great length, the case of a poor woman who suffered much from neuralgia of the mamma, which could not be removed by an external application. There was no degree of pain, of inflammation, or hardness in the breast; but, during the paroxysm, the whole breast was acutely sensible. The paroxysms returned five or six times in the course of the day, and were short and transient. He adds, "the twitching or snatches in the shoulder were at

* Vol. iii. p. 297.

one time so considerable, as to give the patient an idea, to use her own words, " that something was alive there."

3. The SUPERIOR SCAPULARY NERVES are connected with the fourth and fifth cervical nerves, and pass through the semilunar notch in the superior costa of the scapula. The branches of this nerve supply the supra-spinatus muscle, and other muscles on the back of the scapula.

4. The INFERIOR SCAPULARY NERVES pass along the lower edge of the subscapulary muscle, and accompany the infra-scapulary artery, and sends branches to the latissimus dorsi.

5. The ARTICULAR NERVES, which sink deep in the axilla, pass along the under-edge of the subscapularis. It almost surrounds the neck of the os humeri. These nerves appear to be connected chiefly with the trunk common to the fourth and fifth cervical nerves. These nerves accompany the posterior circumflex artery, around the os humeri. From this plexus, small nerves are distributed upon the teres major and the deltoid muscles, and also on the capsular ligament of the shoulder-joint. I had occasion to be consulted by a gentleman whose shoulder had been dislocated. For ten months afterwards, he could not raise his arm, which probably originated from the injury done to this nerve, which is spent upon the deltoid muscle.

6. The RADIAL OR MEDIAN NERVE is connected with the lower part of the axillary plexus. This nerve is placed before the trunk of the humeral artery, to which it is intimately united by cellular substance; and it accompanies it to the elbow-joint; and, at the elbow-joint, the nerve is placed on the inner side of the artery.

At the elbow-joint it passes over the tendon of the brachialis internus; and having perforated the back part of the pronator teres, descends between the flexor carpi radialis and flexor sublimis, to which muscle it sends off small branches, near to the elbow. This nerve gives off branches, which go to the pronator teres muscle, and the flexor carpi radialis and sublimis.

From the radial nerve, a large branch, called *interosseous*, is derived, as it passes along the interosseous ligament.

The interosseous nerve, in its course to the wrist, supplies the flexor muscles of the thumb and fingers, and terminates on the pronator radii quadratus.

The trunk of the radial nerve, near to the wrist, is placed near to the skin: it passes under the annular ligament of the wrist to the palm of the hand, where it is covered by a thin tendinous aponeurosis; and, in that situation, divides into seven branches; two of which lead to the thumb, and one to the side of the fore-finger next the thumb. The other branches are derived from two trunks, and supply the opposite side of the fore-finger, both sides of the middle finger, and the side of the ring-finger, next the middle finger.

There are several smaller nerves also sent from the radial nerve, which are distributed upon the lumbricales muscles; and there are others which accompany the branches which form the superficial palmer arch.

The nerves of the opposite sides of the fingers are united at their points, and at length terminate by a great many small nerves.

It has been long known that a ligature applied around a nerve, occasions the death of the animal.

Larry has made mention of two persons who died from tetanus, from the effect of a ligature upon a nerve. The arm of one of the patients had been amputated, and the radial nerve was included in the ligature along with the humeral artery.

The nerve, we are informed, below the ligature, swelled like a mushroom, and that above was much enlarged of a reddish hue.

In the other case, in which the leg had been amputated, the extremities of the nerves were much swollen.

Portal has also made mention of the swelling of the sciatic nerve, from the effects of a ligature.

Larry obviated the effect of the ligature upon the nerve, by passing a grooved stylet between the artery and the ligature, and by passing the blade of a very fine pair of scissars in the groove, and cutting the thread.

In the palm of the hand, I have seen a branch of the nerve form a communication between the radial and ulnar nerves.

Mr SWAN states, that he has traced the branches of the radial nerve into the tendons on the back of the hand, and "that filaments from the digital nerves creep into the thecæ, and enter the tendons."

7th, The ULNAR NERVE has been also called the *cubital*, by HALLER and WINSLOW, and by ALBINUS, in his edition of the engravings of EUSTACHIUS *quartus brachialium*.

It is derived chiefly from the last cervical and first dorsal nerve. This large nerve passes along the triceps muscle; along with the arteria profunda minor, and is at no great distance from the skin; and at the elbow, occupies the groove between the inner condyle of the os humeri and olecranon ulnæ.

The nerve then passes through the heads of the flexor carpi ulnaris, and follows the same course as that ulnar artery along the fore-arm, and to the inner side of the pisiform bone at the wrist, and between the flexor carpi ulnaris and flexor digitorum sublimis.

Near to the lower end of the ulna, it becomes subcutaneous. There are *two or three small branches* sent off from it, which pass to the back of the hand, between the ulna and the flexor carpi ulnaris; from which there are various small nerves, which supply the wrist, and which join with the branches of the spiral nerve on the back of the hand, and which sends a branch to the little finger, and also to the ring and middle fingers.

There is another *considerable branch* sent off from the nerve, before it passes into the palm of the hand, which runs along the ulnar side of the little finger, and is subdivided into two branches; one of which runs on the side of the little finger, and the other on the side of the ring-finger, next the little finger.

The trunk of the ulnar nerve passes over the annular ligament of the wrist along with, and on the inner side of, the ulnar artery: it passes beneath the tendinous aponeurosis of the palm of the hand, and having reached the palm of the hand,

is subdivided into *superficial* and *deep seated branches;* the former of which is distributed upon the muscles of the little finger, and the opposite sides of the little finger.

The *deeper seated branches* of the ulnar nerve in the palm of the hand, pass between the abductor and flexor parvus minimi digiti, and then form an arch, which accompanies the branches of the radial artery; and from this deep seated arch there *are branches derived*, which supply the abductor minimi digiti, the flexor brevis, abductor pollicis, lumbricales, and interossei muscles.

From the branches of the nerves which supply the fingers, there are many *lateral branches*, which are distributed upon the muscles of the fingers, and which at last terminate upon the points of the fingers, by a number of small fibrils.

There are many anastomoses between the smaller branches of the radial and ulnar nerves, which also holds true in respect to the nerves on the palmar and dorsal sides of the fingers.

It may not be improper to add, that, under the axilla, the ulnar and spiral nerves are united by small branches, from which union a small branch is sent, which passes under the skin which covers the triceps muscle *.

8th, The SPIRAL NERVE, the largest nerve derived from the axillary plexus, is placed between the ulnar nerve and axillary artery: it passes downwards obliquely between two of the heads of the triceps, and afterwards to the outer side of the arm; and it is accompanied, in that course, by the spiral artery.

In its course along the posterior part of the os humeri, there are several branches detached from it to the triceps muscle, and one accompanies the spinal artery, and is spent upon the extensor muscles of the fore-arm.

There is also a subcutaneous branch sent off behind the os humeri, which passes down to the back-part of the fore-arm, and back-part of the hand, and joins with the branches of the ulnar nerve.

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* Vide CAMPER's Views of the Nerves of the Arm.

The trunk of the nerve, at the elbow-joint, is imbedded in the groove between the extensores carpi radiales, and brachiales, and brachialis internus; and when so situated, detaches several small branches to the extensor and flexor muscles.

Opposite to the head of the radius, the trunk of the nerve is subdivided into *two great branches*, one of which is *deep-seated*, the other *more superficial*.

The *superficial branch* descends along with the radial artery, and below the middle of the radius, is subdivided into the *volar* and *dorsal* branches. The former is distributed upon the annular ligament and muscles of the thumb; the latter divides into a number of small branches, which are distributed upon the muscles, in the vicinity of the metacarpal bones and fore-finger; and there are also *branches* of this nerve which are proper to the fore and middle fingers, and to the side of the ring-finger, next to the middle-finger.

The *deep-seated branch* supplies the extensores carpi radiales, perforates the supinator radii, and reaches the back-part of the fore-arm, and, descending along the extensor primi internodii pollicis, arrives at the back-part of the hand, and annular ligament of the wrist, and at length terminates on the back-part of the metacarpus.

My Father traced a branch of this nerve passing into the back-part of the ligament of the carpus; although HALLER has denied that nerves can be traced into ligaments *.

Mr SWAN informs us, that he also had traced nerves into the ligaments of the wrist, from the radial and dorsal branches of the ulnar nerves, and likewise from the posterior interosseous. He also observes, that "many branches may be traced to the ligaments from the deep branch of the anterior tibial †."

9th, The MUSCULO-CUTANEUS, or PERFORANS CASSERII, generally perforates the upper-part of the coraco-brachialis muscle, and afterwards passing between the scapulo-radialis,

* Vide Nervous System, p. 66.

† Vide Page 9. of his Observations on the Nervous System.

and brachialis internus muscles, to both of which it gives many small branches, gets to the outer side of the tendon of the scapulo-radialis muscle, and passes behind the median cephalic vein. This nerve passes down the arm, under the skin, and over the supinator radii longus, as far as the root of the thumb, where it anastomoses with the superficial branch of the musculo-spiral, and gives also branches to the back of the hand.

This nerve has sometimes been injured in opening the cephalic vein, at the elbow.

10*th*, The NERVUS CUTANEUS, so named, from its situation under the skin, passes down along the inner and fore part of the arm. In its course downwards it supplies the coraco-brachialis muscle; and, at the elbow-joint, or a little higher, is divided *into three or four branches*, which have been named, from their situation on the outer and inner sides of the arm, *external* and *internal*.

The *external* passes behind, and its other branches pass before the median basilic vein, and afterwards suddenly divides into a number of very small nerves, which are spent upon the elbow-joint and fore-arm.

This nerve may be wounded in performing venesection, even by the most skilful anatomist.

The *internal* branch, which is rather smaller than the preceding, crosses over the basilic vein to the inner side of the elbow, and terminates on the inner side of the fore-arm.

11*th*, The CUTANEUS INTERNUS OF WRISBERG. The cutaneus internus of Wrisberg also takes its rise from the axillary plexus.

This nerve, which is smaller than the former, divides into two branches: the larger descends along the back-part of the triceps, and disappears at the under part of that muscle. The former winds round to the back-part of the arm, and is spent upon the triceps.

The nerves, called the INTERCOSTO-HUMERALES, derived from the second and third intercostal nerves, are distributed upon the fore and lateral parts of the thorax, and upon the

axillary glands, and parts in their vicinity, on the inner side of the arm.

One of the intercosto-humeral nerves joins with the internal cutaneous of WRISBERG, and afterwards sends several very small nerves, which are distributed on the axillary glands, on the back-part of the arm.

I received the arm of a soldier, that had been amputated, on account of the very excruciating pain, which he had, for several years suffered, and which very much resembled that kind of pain which accompanies an irritation applied to a nerve.

From the account the patient gave, the pain which came in paroxysms followed the course of the median nerve, and had been occasioned by a wound from a bayonet.

Conceiving that the patient's sufferings originated from an injured nerve, I requested of my assistant Mr MACKENZIE to throw a fine injection into the bloodvessels of the arm, and then to examine the nerves, with great care. He accordingly did so; the median and ulnar nerves were evidently enlarged, and in a high state of inflammation; and the injection had proved so successful, that the above, and the cutaneous nerves, resembled red cords, and bear a very strong resemblance to an artery that has been filled by a red injection; for the various threads, or rather fasciculi of the nerves, are by no means so obvious as in a healthy nerve.

Of the Nerves of the Chest.

The nerves which supply the parietes of the chest, and parts contained within it, are the pars vaga of the eighth pair, the great sympathetic, and the intercostal nerves.

Of the Phrenic Nerve.

The phrenic nerve is formed by the union of the third, fourth, and fifth cervical nerves. KRUGER* has observed, that two branches of the fourth cervical nerve go to form the phrenic nerve.

This nerve descends along the fore-part of the anterior

* Vide his Dissertation on the Phrenic Nerve.

scalenus muscle, and in its progress receives a branch from the fifth cervical: it enters the chest, between the subclavian artery and vein; passes along the root of the lungs, and then along the pericardium, and ultimately divides into a number of branches, which are distributed upon the diaphragm.

The ultimate branches of this nerve are spent upon the abdominal surface of the diaphragm; and PETIT has remarked, in his edition of PALFYN's Anatomy, that they communicate with the small branches of the splanchnic and intercostal nerves.

The phrenic nerve of the right side follows nearly a straight course, but that of the left side describes a considerable sweep, corresponding with that part of the pericardium which is opposed to the apex of the heart.

From the immediate conjunction of the nerves, which concur in forming the phrenic nerve, the symptoms attending that remarkable disease, called *Risus Sardonicus*, may perhaps be explained.

The third pair of cervical nerves is joined with the auricular branches of the seventh pair. The rest of the portio dura is spent upon the muscles of the face; a part of it communicates with the second branch of the fifth pair, and also with the third branch of the fifth pair.

My colleague Dr GRAHAM sent to the Museum a specimen, taken from the body of a woman who had laboured under severe cough and difficult breathing. The lungs were found quite sound, but the spinal canal was found much contracted at its upper part, the tooth process of the second vertebra being much enlarged; hence it seemed probable, that the pressure on the spinal cord, above the phrenic nerve, had been the cause of the difficulty in breathing, and death of the patient, in the same manner as the fracture and displacement of the cervical vertebræ above the third and fourth cervical vertebræ generally proves a cause of instant death, the diaphragm being thereby paralysed, and incapable of continuing respiration.

Of the Par Vagum of the Eighth Pair of Nerves.

Upon the recurrent nerve being detached from the eighth pair of nerves, there is a *plexus of nerves* formed by the small branches passing from the recurrent nerves of opposite sides, and by the branches of the sympathetic nerves, which go to the heart. This plexus covers the larger branches of the pulmonary artery; and there are some small branches of nerves which creep along the smaller ramifications of the pulmonary artery.

This plexus has been called the *anterior plexus of nerves*, in contradistinction to the *posterior pulmonary plexus*, formed by the eighth pair, and which are situated behind the root of the lungs.

The smaller branches of this plexus accompany the branches of the air-tubes, and of the pulmonary bloodvessels within the substance of the lungs; and from this plexus some small nerves are sent to the heart.

The pulmonary plexuses being detached, the eighth pair divides into cords, which surround the œsophagus, and which form what anatomists have described as the *œsophagean plexuses*.

These plexuses of nerves have been extremely well represented by Professor Scarpa, though it appears to me that the branches are larger than I have seen them in nature.

Of the Cardiac Nerves.

The cardiac nerves are derived from the eighth pair, and also from the sympathetic nerve, chiefly from the latter. Some filaments are derived from the sympathetic nerve in its progress along the neck, but the greater number are derived from that nerve in its progress through the thorax.

Of the Cardiac Nerves of the Right Side.

On the right side there are three principal *cardiac nerves*. The superior cardiac nerve is derived from the uppermost cervical ganglion, and also from some filaments of the laryngeal nerve.

This nerve creeps along the common carotid artery as far

as the lower cervical ganglion; the trunk then divides, one part passes along the arteria innominata to the aorta, and the other joins a plexus below the middle ganglion.

The middle or greatest cardiac nerve is connected with the middle cervical ganglion; it passes in front of the carotid artery, crosses the root of the subclavian, then passes along the arteria innominata, where the cardiac nerves of the left side are added: thus, the *plexus cardiacus magnus* of HALLER is formed, it is placed between the aorta and the windpipe. Many of the branches of this plexus pass around the aorta and pulmonary artery, and are fixed down to these vessels by the internal lamina of the pericardium; and branches from this plexus pass along the coronary arteries to the apex of the heart,—which is very distinctly seen in the heart of a lean horse or ox.

From this plexus a branch is sent to the *left coronary* plexus, branches, which creep along the right branch of the pulmonary artery to the heart, and a branch to the anterior coronary plexus.

The *lesser cardiac nerve* takes its rise from the lower cervical ganglion, by a number of small nerves, which form a plexus; passes along the arteria innominata and aorta, and ends in a plexus formed by the cardiac nerves on the left side of the aorta ascendens.

Of the Cardiac Nerves of the Left Side.

These are derived from the eighth pair and great sympathetic nerve. A nerve is generally sent off from the eighth pair, about three inches above the collar-bone: it passes in the back part of the sheath of the common carotid artery, and unites with a branch of the great sympathetic nerve, which had received branches from the third cervical nerve.

The left cardiac nerves are *superficial* or *deep-seated.*

The superficial passes behind the arch of the aorta, to the *great cardiac plexus.*

The deeper-seated cardiac nerve passes across the fore part of the arch of the aorta; joins the *cardiac nerves* of the eighth pair, and forms the *cardiac plexus;* and from this plexus, a nervous web extends on the left side of the ascending aorta,

from which the *right coronary plexus* is derived, which passes between the pulmonary artery and aorta, and then along the coronary vessels.

From the great cardiac plexus of the left side, a *nervous plexus* extends *on the left coronary artery;* and from this, small nerves creep along the surface of the left coronary arteries to the point of the heart *.

The cardiac nerves being sent off, the sympathetic nerves unite into a trunk behind the subclavian artery, and descend along the heads, and over the heads of the ribs, and a ganglion is formed by their junction with the intercostal nerves †.

From the sixth, seventh, and eighth dorsal ganglia, branches arise, which form the nerve called by HALLER *nervus splanchnicus*, which passes through the appendix of the diaphragm, and supplies the bowels of the abdomen.

The sympathetic nerve forms an intricate plexus upon the vertebral artery; it passes between the left carotid and left subclavian arteries, and give many filaments to the last named artery. The sympathetic nerve then divides into two parts, one of which passes over the fore-part of the left bronchus, and is lost in a plexus placed behind the pulmonary veins.

The other or greater part of the sympathetic nerve passes along the back-part of the subclavian artery, forming along it an intricate plexus; it also sends many filaments over the fore-part of the subclavian artery, several of which unite with the superficial cardiac nerves, and form a plexus on the pulmonary artery, from which several filaments proceed to the left auricle of the heart.

Of the Intercostal or Dorsal Nerves.

These nerves, after being sent off from the spinal marrow, are lodged in the grooves in the lower edges of the ribs, and advance to the fore-part of the chest between the intercostal muscles.

There are branches of these nerves which supply the mus-

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* Vide SCARPA's Third Plate of the Nerves of the Neck.

† Vide MONRO's Nervous System, Plate xi.

cles in the vicinity of the spine, the intercostal muscles, and also those of the abdomen.

The superior intercostal nerves supply by their branches the upper and outer part of the chest and the mammæ.

The lower intercostals supply the muscles of the thorax and of the abdomen.

After the intercostal nerves have passed between the vertebræ, they are connected with the great sympathetic nerve, and form ganglia.

Mercury, according to Mr SWAN*, affects very much the ganglion of the sympathetic nerve. He gave a dog mercury for some time; he killed him, and found "all the ganglion of the grand sympathetic nerves were very much inflamed, and especially the superior cervical.

"May not," says my Grandfather, "the communications of all these nerves be one reason why the parts act so uniformly and conjunctly in respiration, and conspire together in the convulsive motions of coughing, sneezing, and the twitching spasms that happen sometimes in different parts of the muscles of the abdomen, by an irritation on the lower dorsal nerves, are in danger of occasioning a mistake in practice, by their resemblance to colic, nephritis, &c. The communications of these lower ones with the intercostals, may serve to explain the violent effort of the abdominal muscles in a tenesmus, and child-bearing."

From these ganglia branches are derived which supply the extensor muscles of the body.

The trunk of the intercostal nerve enters into the axillary plexus, and a branch from it runs along the edge of the first rib.

The intercostal nerves, in their progress along the grooves of the ribs, give nerves to the intercostal muscles, and to the serratus magnus, even to the skin of the thorax, and to the upper part of the abdominal muscles.

There are also branches of the intercostal nerves which are

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* Vide his Inquiry into the Action of Mercury, p. 81.

reflected along with the branches of the intercostal mammary artery, which are ultimately spent upon the mammæ.

The lower intercostal nerves supply the adjacent muscles, and also the abdominal muscles, and the skin of the belly.

The twelth intercostal nerve sends nerves which extends to the integuments of the pelvis.

Of the Thoracic part of the Sympathetic Nerve.

According to Lobstein, the Sympathetic nerve is a continued cord, passing from the head to the pelvis, which has various ganglia connected with it, and which is very rarely distinctly interrupted.

The Sympathetic nerve passes over the head of the first rib, and the heads of the other ribs, and forms ganglia with the intercostal nerves, which enters the ganglia by two branches. My Father has minutely described the structure of these ganglia, and also Professor Scarpa *,—these authors differ but little in their descriptions of these ganglia.

Within these few years Weber † and Wutzer ‡ have also published on the ganglia of the nerves, and Lobstein has very lately directed his attention to the same subject, in his book upon the Sympathetic Nerve.

The ganglia are, like the brain, composed of a grey and of a white substance, which latter, like the nerves, is of a fibrous structure.

The fibres which enter the ganglia lay aside their neurilma.

Scarpa has described a fatty substance, as existing in the ganglia of fat subjects, but this I have not observed: I agree with Lobstein in opinion, that it is rather a yellowish jelly. Concerning this jelly Lobstein has observed, that he had found it most abundant in dropsical persons. He has added, "Frequentior etiam in junioribus hominibus; quo fit ut ganglia aliquam pelluciditatem abeunt. Transit quoque in ramos gangliorum internos atque externos, adeo, ut surculi

* De Nervorum Gangliis et Plexubus; Mutinæ, 1779.

† De System Nerveo; Lipsiæ, 1817.

‡ De Corporis Human. Gangl. fabr.; Berolini, 1817.

gangliorum cervicalium plane diaphani mihi apparuerint in fœtibus, atque hominibus in juvenili ætate mortuis. Sed longe abest, ut succus iste certum ac constans sit phænomenon, et ad normalem gangliorum statum jure meritoque sit referendus. Parissime occurrit gangliis thoracicis atque plexibus cardiaco et pulmonalibus; frequentius autem (usque ad certam atque definitam ætatem), in collo, in ramis quibusdam anastomaticis nervorum spinalium, ac in nervis plexum caroticum constituentibus e quibus nervi sic dicti molles diutissime illum succum retinere videntur." According to Lobstein, the ganglia differ from each other in colour, size, and hardness. The ganglia cervicale supremum is longer, softer, and redder, than the semilunar ganglia.

The ganglia are supplied by small arteries from the neighbouring arteries, and these have corresponding veins.

Lymphatic vessels, in many parts of the body, are distributed around the ganglia, but I have never seen these within the substance of the ganglia.

From the uppermost ganglia, small nerves are sent to the posterior pulmonary plexus.

The sixth, seventh, eighth, and ninth thoracic ganglia, concur in forming a considerable trunk, called the *Greater Splanchnic Nerve*, as it is spent upon the bowels of the abdomen; and from the tenth, eleventh, and twelfth dorsal ganglia, *the Lesser splanchnic nerve is sent off*, which unites with the greater splanchnic, and the rest of it goes into the renal plexus.

At the inferior part of the thorax, the sympathetic nerve passes into the abdomen beneath the crus of the diaphragm.

Dr Wilson Philip, after having described the sympathetic nerve, has observed:—"Thus the sympathetic nerve, conveying the influence of the spinal-marrow, and the par vagum, that of the brain, unite in forming the ganglions, which, with their plexuses, constitute a secondary centre of nervous influence, a channel through which the influence of every part of the brain and spinal marrow flows, to be bestowed on the thorax and abdominal viscera, on the vessels, and all secreting surfaces, the most important of which parts, we have, by

direct experiment, found subjected to every part of the brain and spinal marrow.

Of the Nerves of the Chylopoëtic and Assistant Chylopoëtic Viscera.

The nerves of the chylopoëtic, and assistant chylopëetic viscera, are derived from the *sympathetic nerve;* the *par vagum of the eighth pair of nerves;* and the *rami splanchnici.*

The RAMI SPLANCHNICI arise from the sympathetic nerves; they pass through the upper and lateral parts of the smaller diaphragm, and join the greater semilunar ganglion, formed by the conjoined eighth pairs of nerves and ramini splanchnici.

The PAR VAGUM of the left side having passed along the gullet, gets to the fore-part of the upper orifice of the stomach, and divides into a number of small nerves, which are distributed on the upper surface of the stomach; and a few filaments from this nerve join the left hepatic plexus.

The PAR VAGUM of the right side, situated upon the back part of the stomach, divides into two plexuses; one of which joins the hepatic plexus; the other is distributed upon the great left sac of the stomach.

The SEMILUNAR SOLAR GANGLION *, formed by the paria vaga and the rami splanchnici, is of an irregular form, having its curved edge downwards, and is composed of several smaller ganglia, called *Cœliac*, which vary in size.

This ganglion lies on the crus of the diaphragm, and on the cœliac and superior mesenteric arteries.

It is formed of a series of small ganglia, united to each other by condensed cellular substance.

From this ganglion, called the *semilunar solar*, nerves are derived, which accompany the cœliac artery and its branches.

LOBSTEIN has described and represented in his Plate X., bodies above the size of small peas, which are connected with the semilunar solar ganglion.

* Vide WALTERI Tab. Nerv.

The nature of these bodies is unknown.

The CŒLIAC GANGLION covers the aorta, and the roots of the cœliac and superior mesenteric arteries, from which a nervous plexus is derived, which covers the trunks and branches of the cœliac and the superior mesenteric arteries.

From this ganglion the hepatic plexuses are also derived.

From the right hepatic plexus, the right extremity of the pancreas is supplied; the pyloric portion of the stomach; the duodenum, and the greater curvature of the stomach.

The branches of the hepatic plexus also accompany the branches of the hepatic artery and vena portarum through the substance of the liver; and are also distributed upon the gall-bladder and biliary ducts.

The SPLENIC PLEXUS of nerves accompanies the splenic artery, and also the smaller branches of the splenic artery, into the substance of the spleen.

The SUPERIOR and INFERIOR MESENTERIC *Plexus of Nerves* form sheaths, which envelope the trunks and branches of the corresponding arteries.

From these sheaths, very small nerves are derived, which are distributed over the surface of the mesentery, and the mesenteric glands.

The nerves of the colon are proportionally larger than those of the smaller intestines, and are frequently united.

The inferior plexus of nerves is continued downwards along the bloodvessels of the left portion of the colon, and the intestinum curvum.

The aorta is included within a plexus of nerves, called the *Hypogastric:* this passes over the aorta, where it lies upon the lowest lumbar vertebræ, and divides into right and left parts, which are distributed upon the bowels of the pelvis.

Some authors have described the omental pancreatic umbilical plexus, but these are only branches, derived from the solar plexus.

Of the Nerves.

Mr SWAN has described nerves from the great sympathe-

tic, passing into the peritonæum forming the mesentery, and likewise to the pleura. He adds, "Branches may be also traced from the par vagum, phrenic and grand sympathetic nerves, to the pericardium *."

Lobstein has also observed †, "Ad alias vero partes præter vasa atque viscera properant ramuli nervei e gangliis emissi. Plurimi ad musculos eunt voluntatis imperio subjectos, ad musculum scilicet longum colli, ad intercostales, juxta Walterum, ad septum transversum.

"Surculi aliquot in ligamentis vertebrarum absumuntur, potissimum in regione lumbali, alii vasorum ramulos insequentes, in corpora vertebrarum ipsa se immittere videbantur."

When we examine, with very considerable care, the web that involves the cœliac, splenic, hepatic, superior, and inferior mesenteric arteries, we see distinctly, even with the naked eye, very minute nerves passing along it, in very different directions, and forming upon it a very intricate plexus; and, upon using a magnifying glass, still smaller plexuses come into view.

This mode of distribution of nerves is not peculiar to the sympathetic nerves: it occurs, as has been stated, upon the surfaces of other arteries, as upon the internal carotid, lingual arteries, on the pulmonary artery, and upon the aorta, but also upon the lamina spiralis of the cochlea, and also of the retina, and on the face, and even extremities of the body, as has been shewn by Mr Swan, in several engravings affixed to his book on the Nervous System.

Whether nerves proceed from this cellular web into the coats of the arteries, remains yet to be further investigated.

I have seen a fine thread or threads, passing from the web into the substance of the arteries; but whether that thread was a nerve, or a portion of the web, which, by the way, is much tougher than a web of common cellular substance, I cannot say, on account of the similarity as to the toughness and colour of that substance, and a filament of a nerve.

* Page 9., on the Nervous System. † Page 41.

Walter Lucoe and Lobstein have stated, that they had traced small nerves into the substance of the arteries.

Lobstein describes small twigs as passing from the superficial cardiac nerve of the right side, through the substance of the aorta into its second coat.

Bock affirms, that minute branches from the sympathetic nerve enter the coats of the carotid artery.

Though I have employed the term cellular web of the nerves, I did so only in obedience to general custom, and for want of a better name: it is more appropriate to call it the *connecting membrane* of the minuter ramifications of the nerves; for, if it be examined in a very recent body, it is found to be of a tougher, and of a much more compact nature, than cellular substance; it has somewhat of a silvery appearance, and, besides, it is not cellular; there are no intervening spaces between its layer, and I have never seen, even in the worst cases of dropsy, any watery fluid contained in it, or in cases of peritonites, purulent matter.

As to the condition of the sympathetic nerve of the fœtus, we have much accurate information from the laborious Lobstein.

For these minute details, I must refer my reader to the author himself, having only room to add, that he has stated the trunk of the sympathetic nerve to be distinct in the embryo of five months, forming a continuous thread, which extended without interruption from the head to the pelvis.

As to the state of this nerve in old age, like other nerves, it shrinks very much, and also the ganglia connected with it.

With regard to the intimate structure of the sympathetic nerve, Lobstein differs from Bichat, who supposed the sympathetic nerve to be only a nerve connecting the several ganglia. He never found the sympathetic nerve to be interrupted either in the thorax, abdomen, or pelvis: he observes, "sed tenerrima filamenta quæ truncum componunt ganglia trajiciunt, tramite non interscisso."

Of the Nerves of the Organs of Urine and Generation.

A plexus of nerves is derived from the cœliac plexus, and from the great sympathetic nerve, which envelope the renal arteries and their branches.

It is divided into an anterior and posterior part, which accompany the branches of the renal artery within the substance of the kidney.

From the renal plexus, there are small nerves, which are distributed upon the renal glands, and also upon the upper portion of the ureter, and the under part of the ureter is supplied with nerves from the hypogastric plexus. There are a few fibres derived from this plexus, which join with nerves from the first and second lumbar nerves which accompany the spermatic artery along the spermatic cord to the testes; and in the female they creep along the round ligament of the female womb, and some of the smaller branches pass to the ovarium and Fallopian tube.

The spermatic nerves, which follow the same course as the spermatic artery, are derived from the renal and aortic plexuses, and form the second lumbar nerves.

In WALTER's Plates of the Nerves of the Viscera of the Abdomen and Pelvis, the nerves of the uterus are represented; but TIEDEMANN has stated, that he has omitted those which issue out from the great hypogastric plexus, and that he did not trace the nerves into the substance of the uterus.

Dr WILLIAM HUNTER has faithfully described the origin of the nerves of the uterus from the sympathetic nerve, and also those from the great hypogastric plexus; but, according te TIEDEMANN, he has made no mention of the inferior uterine nerves.

TIEDEMANN therefore supposes, that he has published the most perfect account of the nerves of the uterus; he has traced the nerves in the unimpregnated state, and also after delivery. His own words describing them, are given in a preceding part of this book.

It may be added, that the minuter filaments of the nerves

of the uterus, like those of the heart, are soft, of a reddish colour, and cannot be traced through the substance of that organ.

The pudic nerves, which are branches of the sciatic nerves, follow the same course as the pudic arteries.

In making a preparation of the nerves of the dorsum penis some years ago, I observed the membranous appearance connected with the smaller branches of the nerves.

My late pupil Mr Swan has described a similar appearance connected with other nerves, and he has stated, that, upon examining this delicate membrane with a magnifying glass, he found that it consists of a very minute plexus of nerves.

The pudic nerves, which are branches of the sciatic nerves, follow the same course as the pudic arteries.

The pudic nerves consist of two fasciculi, the uppermost of which is derived from the two inferior and two superior sacral nerves.

The fasciculi pass through the under part of the notch of the os ilium, then between the sacro-sciatic ligaments, and accompany the branches of the pudic artery.

The pudic nerve may be wounded in performing the lateral operation of lithotomy; and in the extraction of the stone, all the nerves of the perinæum may be dreadfully bruised, if that extraction shall not be performed in the axis of the pelvis, and when the incisions are not sufficiently large; and this probably gives rise to nausea, vomiting, and other bad symptoms.

The principal nerve of the penis is called the *dorsal nerve;* it is placed between the corresponding artery and vein, and running along the dorsum penis, terminates on the glans, after having given branches to the corpora cavernosa penis.

Haller, and also Bichat, have stated, that the sympathetic nerve is sometimes interrupted; but this is denied by Weber and also by Lobstein.

The almost universal connection and communication which this nerve has with the other nerves of the body, may lead us to understand the following, and a great many more phenomena.

Very various opinions have been held respecting the functions of the sympathetic nerve, all of which the limited nature of this book does not afford space for inserting.

By means of the sympathetic nerve, there is a general sympathy between different and distant parts of the body.

My Grandfather has observed, that it is thus explained "why tickling the nose causes sneezing;—why the too great quantity of bile in the *cholera* occasions vomiting, as well as purging;—why people vomit in cholics, in inflammations, or other irritations of the liver, or of the ducts going from it and the gall-bladder;—why a stone in the kidneys, or ureters, or any other cause irritating those organs, should so much more frequently bring on vomiting, and other disorders of the stomach, than the stone, or any other stimulating cause in the bladder does;—why vomiting is a symptom of danger after childbirth, lithotomy, and other operations on the parts in the pelvis;—why the obstructions of the *menses* are capable of occasioning stangulations, belching, cholics, stomach-achs, and even convulsions in the extremities;—why vesicatories, applied from the ears to the clavicles of children labouring under the *tussis convulsiva*, are frequently of great service;—why worms in the stomach or guts, excite an itching in the nose, or grinding of the teeth;—why irritation in the bowels or the belly, occasion sometimes universal convulsions of the body *."

The par vagum is the chief medium of communication between the brain and the viscera of the thorax and abdomen; and it has not unaptly been therefore called by Wrisberg, *Fascia communicans.*

The sympathetic nerve has been supposed to be subservient to nutrition.

The experiments which I performed, were attended with a different result from those of Mr Depuy, who informs us, that, by cutting out the cervical ganglia of either side of a horse, there was a wasting of the whole body and swelling of

* Page 358., Quarto Edit.

the feet *. In the rabbits, the subjects of my experiments, there was no wasting, no obvious derangement in the functions of the viscera; on the contrary, one of the subjects of the experiments had young in the course of eight weeks after she had been operated upon.

Lobstein adopts the opinion of authors, that the different parts of the sympathetic nerves are sources of nervous energy, upon which the healthy fuuctions of the viscera depend; and that the ganglia are laboratories of nervous energy. He also supposes, that mental impressions operate through the medium of the semi-lunar ganglia, which he calls *Cerebrum abominale.*

The nervous energy is supposed to be diffused by the cellular tissue in which the very minute branches of the sympathetic nerve are lost; and, with the view of ascertaining the influence of the sympathetic nerve upon the organs upon which its branches are distributed, he killed dogs and cats, by wounding the spinal cord; and having ascertained the animals to be dead, he endeavoured to excite the sympathetic nerves, but the organs supplied from that source *were not affected in the slightest manner;* and by applying galvanism to the sympathetic nerves, the heart, stomach, and intestines, *did not move*; the peristaltic motion continued, but it was not all dependent on the galvanic stimulus.

OF THE NERVES OF THE LOINS, AND INFERIOR EXTREMITIES.

The nerves of the loins and inferior extremities are derived from the *sympathetic*, *lumbar*, and *sacral nerves.*

Of the Sympathetic Nerves.

The Sympathetic Nerves, after supplying the abdomen, approach each other upon the anterior part of the lumbar vertebræ, between the psoas muscle and the tendinous crura of the diaphragm. These nerves descend, then pass over the anterior part of the os sacrum, at the inner sides of the fora-

* Journal de Medicine, 1816.

mina of the os sacrum, and terminate upon the surface of the ossa coccygis, when they are united by a transverse nerve.

The sympathetic nerve forms ganglia with the lumbar nerves; and, in the pelvis, it also forms ganglia, which are connected to the sacral nerves.

The sympathetic nerves, during their course to the ossa coccygis, are united with the lumbar and sacral nerves by ganglia. Small nerves take their rise from the sympathetic, in its progress through the pelvis, which are spent upon the coccygeus muscle, and upon the lower share of the intestinum rectum.

Of the Lumbar Nerves.

The five lumbar nerves are connected with the sympathetic nerves, and with each other; and, from the lumbar plexus, behind the psoas muscle, nerves are derived, which supply the fore-part of the inferior extremity.

The plexus of lumbar nerves is formed by a branch from the last dorsal nerve, and by the four uppermost lumbar nerves. The anterior branches only form the plexus; for the posterior go to the back. The external spermatic nerves are derived from the upper part of this plexus: it passes to the anterior superior spinous process of the os ilium; creeps along the posterior surface of POUPART'S ligament, and reaches the spermatic cord, at the upper abdominal aperture, and it is spent on the spermatic cord and scrotum; or, in the female, having passed along the round ligament, it at length is spent on the labia pudendi.

The first pair of Lumbar Nerves is connected with the twelfth dorsal, and with the second lumbar. This pair of nerves furnishes branches to the muscles of the loins, scrotum, and to the muscles of the upper parts of the thighs.

The second pair of Lumbar Nerves perforates the psoas muscles, to which it gives branches; and detaches also the spermatic nerve, which descends along the spermatic vessels; and, above the upper abdominal aperture, divides into two branches, one of which is distributed upon the pubes, scro-

tum and testis of the male, and upon the round ligament of the female uterus, and external parts of generation; and the other branch creeps along the femoral artery, and terminates on the fore-part of the thigh. A third branch passes behind the psoas, and across the iliacus internus, and is distributed upon the muscles of the upper and inner part of the thigh, and terminates upon the vastus internus, near to the knee.

Branches of the second, third and fourth lumbar nerves, form a nerve which has been named OBTURATOR. This nerve passes behind the psoas muscle, and then downwards and forwards, to the aperture in the ligamentous membrane, which shuts up the foramen obturatorium. This nerve accompanies the branches of the obturator artery, and supplies the obturator internus and pectineus muscles, and then divides into two parts, which are distributed upon the adductor and gracilis muscles of the thigh.

The third and fourth lumbar pairs of nerves are considerably larger than the preceding, and from them the following nerves are derived.

The *Crural Nerve* arises from the middle of the lumbar plexus: it lies beneath the psoas muscle, which detaches branches to the iliacus internus and psoas; and, passing behind the crural arch, and on the iliac side of the femoral artery, is distributed upon the muscles and skin of the upper and lateral parts of the thigh, and is subdivided into *subcutaneous branches*, which are spent upon the middle, fore and inner part of the thigh, and *into deeper seated and larger branches*, which supply the pectineus muscles, the sartorius, triceps adductor femoris, and the four large extensor muscles of the leg.

A branch of this nerve accompanies the femoral artery, till that artery passes between the great adductor muscle and the thigh-bone: the nerve then passes along the front of the adductor, in a tendinous sheath, formed by that muscle and the vastus internus. This nerve accompanies the vena saphæna, and has been called by FISCHER the *Nervus Saphænus*. This nerve supplies the inner and fore-part of

the leg, and is continued to the upper and inner part of the foot. This nerve descends between the sartorius and triceps muscles, and reaches the inner side of the tibia; and, under the knee, it detaches a branch, called the *Nervus Saphænus minor*, which is subdivided into very minute fibrils upon the inner and back part of the leg, and terminates behind the inner ancle.

Of the Sacral Nerves.

A plexus of nerves is formed by the last lumbar, and four uppermost sacral nerves; which plexus is situated at the side of the rectum.

The sacral nerves are six in number, sometimes only five, and arise from the lower part of the cauda equina; they follow an oblique course to the foramina of the os sacrum.

The sacral nerves consist of an *anterior and posterior fasciculus;* the anterior nerves are large, the posterior very small, and distributed upon the back part of the os sacrum and the glutei muscles; and ganglia are formed by the union of the anterior and posterior fasciæ.

The anterior sacral nerves fill up the holes in the anterior part of the sacrum, and are united with each other, and with the branches of the sympathetic nerve; but the posterior nerves are small, and do not fill up the foramina; they are not larger that common sewing-threads.

The first, second, and third sacral nerves pass through holes in the fore-part of the os sacrum; and, by their union with the fourth and fifth lumbar nerves, form the SCIATIC nerve, the largest nerve of the body.

From the sacral nerves, the fasciculi which form the gluteal, ischiatic, and pudic nerves take their rise.

The gluteal nerves are composed of an upper and under fasciculus: these arise from the nerve called by some *Lesser Sciatic.* The superior passes through the upper part of the notch of the os ilium, and below the pyriform muscle, and is subdivided into several branches which supply the smaller gluteus muscles.

The inferior fasciculus passes through the same foramen, and is spent upon the gluteus maximus muscle.

From the fourth sacral nerves, filaments are sent to the hypogastric plexus of nerves, and to the parts around the anus; and the fifth sacral gives nerves to the coccygeus muscles.

The sciatic nerve passes obliquely through the notch of the os ilium; then between the tuber ischii and trochanter major, where it is covered and protected by the gluteus maximus. The sciatic nerve descends in the back part of the thigh between the long flexor and abductor maximus, and then into the ham, where it is called popliteal nerve. In this course, it gives off small branches to the scrotum of the male, and to the labia of the female; to the perineum; to the long head of the biceps; and a few subcutaneous branches, which terminate in the skin of the calf of the leg.

It has been recommended to compress the sciatic nerve, where it passes between the tuber ischii and trochanter major, in order to render the pain the patient suffers during amputation less severe. But upon trial, the compressing that nerve has been found in a short time to create very uneasy sensations, and, in the course of an hour, the pain becomes so great as to be intolerable; the parts on which the nerves are distributed lose their sensation and power of motion, and, on some occasions, the sensation does not return until forty or fifty hours have elapsed.

Mr Swan has published the case of a man afflicted by paraplegia, whose bladder was very much distended. He states, "that, after drawing off two quarts of urine, the lower extremities were more sensible, and that is known to every one, who has been in a position to press the sciatic nerve, and has experienced the sensation that arises when the pressure is removed."

Sudden pressure completely destroys the functions of the nerves. Several instances of persons who have fallen upon the buttocks, have occurred in this city, where the fall was followed by complete insensibility of the inferior extremities. From what has been said respecting the pernicious effects of pressure, it may be supposed that it should never be applied to a nerve. Pressure has been much recommended for the cure

of the brachial and popliteal aneurisms, and it has been employed without any bad consequence following, though it must have been made for some time, and to a considerable degree.

Scarpa, speaking of the effect of pressure in cases of popliteal aneurism, has remarked, that the compressing force must press down, and remove from the artery the concentric coagulated layers of blood, which cannot take place, excepting in a very recent popliteal aneurism of a very small size, and it is necessary that the compression do not injure the sciatic nerve, especially its tibial branches; but, as the nerve is situated immediately below the skin and aponeuroses of the ham this cannot be avoided. Notwithstanding the weight of such an objection to compression, it has been employed successfully, and, in a case of popliteal aneurism, very lately in the hospital of this city.

It may also be observed, that a branch of the sciatic nerve, called the *cutaneous posterior*, takes its origin within the pelvis: it passes out along with the great sciatic, and divides into small branches, which are distributed on the skin of the arms and perineum, and on the skin of the upper and back part of the thigh.

The popliteal nerve placed between the ham-strings, covers the popliteal vein of the ham, and is divided below the knee into an external and internal branch, or into a fibular and tibial nerve.

The tibial and fibular nerves adhere for some little way to each other, and, by slight force, the sciatic nerve, in the middle of the thigh, may be separated into its two component nerves.

The pain which attends the popliteal aneurism, probably originates from this nerve being much stretched by the subjacent tumours.

The fibular or peroneal nerve detaches the cutaneous nerve, which supplies the gastrocnemius muscle; a second branch, passes to the outer part of the leg, and terminates in the same side of the foot; a third branch, which per-

forates the peroneus longus, and which ends in the middle of outer part of the foot.

The fibular nerve also detaches deep seated branches; a branch to the peroneus longus; a branch to the tibialis anticus; to the extensor pollicis, and small nerves which adhere to the coats of the tibial artery. A branch also, which accompanies the anterior tibial artery and its ramifications.

The TIBIAL NERVE passes between the heads of the gastrocnemius; perforates the origin of the gastrocnemius internus; passes between the flexor digitorum longus and the gastrocnemius, and, along with the posterior tibial artery, to the under part of the leg.

The branches of this nerve supply the heads of the gastrocnemius, the tibialis posticus, flexor digitorum, and flexor pollicis muscles: a branch of this nerve, called the *communicans tibiæ*, accompanies the vena saphæna minor.

This nerve at the ancle supplies the skin. A branch of the anterior tibial nerve forms, according to Mr SWAN a gangliform enlargement, branches of which are in contact with the synovial membranes.

The TIBIAL NERVE then passes into the hollow of the os calcis, and divides into the EXTERNAL and INTERAL PLANTAR NERVES.

The external plantar nerve gives branches to the heel; and, passing along the foot, along with the plantar artery, divides into three principal branches. The two first pass forwards to the fourth and fifth toes, and outer side of the left toe. The third branch forms an arch, and corresponds with the external plantar artery; gives branches to the muscles of the little toe, to the lumbricales, interossei and transversalis pedis, and terminates in the muscles of the great toe.

The INTERNAL PLANTAR NERVE passes along the side of the flexor muscle of the great toe, and flexor longus muscle, and gives off branches to the abductor pollicis, flexor digitorum brevis, and lumbricales muscles.

This nerve afterwards sends off four large branches, which accompany the arteries; pass along the plantar sides of all the toes, excepting the little toe, and the outer side of the fourth

TAB. XII.

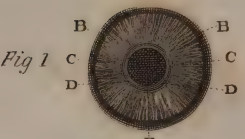
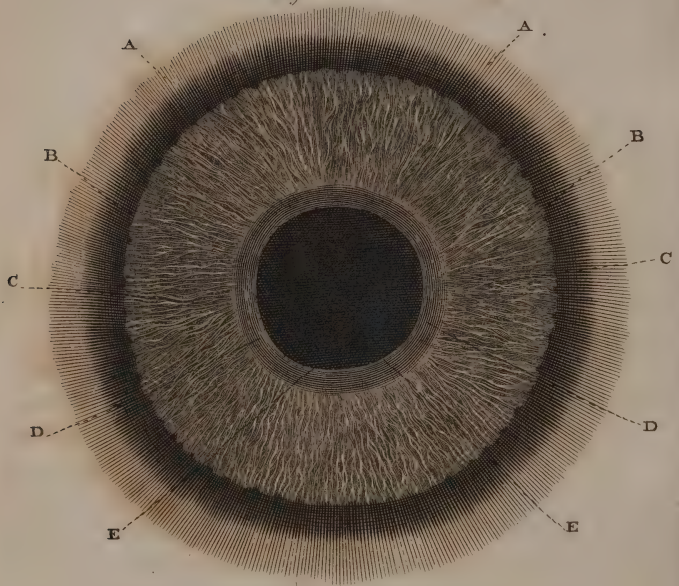


Fig 1

Fig. 2.



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toes, and terminated in the extremities of the toes; and the branches of the nerves of opposite sides communicate freely, so as to form a plexus of bloodvessels upon the points of the toes.

EXPLANATION OF PLATE XII.

The two figures in this Plate, represent the posterior part of the human iris, after the paint has been washed. The object of the plate is to represent the peculiar arrangement of the muscular fibres of the iris; the muscular structure of which has been denied by those distinguished Anatomists Baron Haller and Wrisberg.

Fig. 1. Shews the iris of its natural size; and Fig. 2. represents it magnified.

A A The inner side of the inferior part of the Choroid Coat.
B B The Ciliary Processes.
C C The Vessels and Radiated Fibres.
D D The Muscular Sphincter of the Iris.
E E The Pupil.

While writing the explanation of this Plate, I happened to turn up the Anatomical and Physiological Commentaries of Mr Herbert Mayo, and found that he had made the following experiments to determine the cause of the movements of the iris.

" 1. When the optic nerves are divided in the cranial cavity of a living pigeon, the pupils become fully dilated, and do not contract on the admission of intense light.

" 2. When the third nerves are divided in the cranial cavity of a living pigeon, the same result ensues: in both these cases the surface of the eye-ball retains its feeling.

" 3. When the fifth nerve has been divided on one side in the cranial cavity of a living pigeon, the iris on that side contracts as usual on the admission of light, but the surface of the eye-ball appears to have lost its feeling.

" 4. When the optic nerves are pinched in the cranial cavity of a living pigeon, or immediately after its decapitation, the pupils are contracted for an instant on each injury of the nerves.

" 5. When the third nerves are similarly irritated in the living or dead bird, a like result ensues.

" 6. When the fifth nerve is similarly irritated in the dead bird, no affection of the pupil is observed.

" 7. When the optic nerves have been divided within the cranial cavity of a pigeon immediately after its decapitation, if the portion of the nerves attached to the eyes be pinched, no contraction of the pupil ensues : if the portion adhering to the brain be pinched, a like contraction of the pupil ensues, as if the optic nerves had not been divided.

" 8. The previous division of the fifth nerves in the preceding experiment produces no difference in the result.

" 9. When the third nerves have been divided in the cranial cavity of the living or the dead bird, no change in the pupil ensues on irritating the entire or divided optic nerves.

" It may be inferred from the preceding induction, that diminution of the pupil results from the action, and dilatation of the pupil from relaxation of the iris ; that the nerve which immediately controuls the action of the iris is the third nerve ; that, in the habitual variations of the pupil, an impression is conveyed to the brain along the optic nerve, which is followed by an affection of the third pair, causing the pupil to contract or to dilate ; finally, that the common feeling of the eye is derived from the fifth nerve."

PART VII.

OF THE LYMPHATIC OR ABSORBENT SYSTEM.

CHAP. I.

GENERAL OBSERVATIONS ON THE LYMPHATIC OR ABSORBENT SYSTEM.

AN intimate acquaintance with the origin, course, anastomoses and terminations of the Lymphatic Vessels, cannot but prove of the utmost importance in the study of the animal economy, as these have a great share in several of the operations of the living system. It is also of great moment, in a practical view, because, through the lymphatic vessels, many poisons enter the system, and are propagated through the body; and by the agency of this system, diseases are sometimes removed.

Before proceeding further it seems necessary to describe the lymphatic vessels.

The lymphatic vessels take their rise from every part of the body. They are small pellucid tubes; and being generally filled by a thin watery fluid, have been called, on that account, *Watery Ducts*, or *Lymphatics;* and more lately, *Absorbent Vessels*, on account of their peculiar function.

It would lead me into a very long digression, foreign to the business of an elementary book, to give a minute account of the discovery of these vessels.

It may not be improper, however, to state, that the older anatomists were probably ignorant of the existence of such vessels, and certainly so as to their origin and mode of distribution, which may readily be conceived from the small size and pellucidity of these tubes; and from the art of making anatomical injections being unknown, they had no means of

distinguishing the lymphatic vessels from the smaller branches of the arteries or veins.

The discovery of this system was accidental, and made at different times, by RUDBEC in Sweden, in the year 1662; by BARTHOLINE, Dr JOLIFFE, and PECQUET.

Much is due to ASELLIUS, who discovered the lacteal vessels in a kid, and who had correct views as to the functions of these vessels: for he opened the animal three hours after he had given it food, and saw the lacteal vessels upon the mesentery distended. It is plain he did not comprehend the course of the vessels he had discovered, as he confounded the groups of lacteal glands, at the root of the mesentery, with the pancreas.

The original authors upon the lymphatic system conceived, that this system was an appendage to the arteries, to which the previous discovery of the circulation of the blood, by Dr WILLIAM HARVEY, probably gave rise.

HARVEY had demonstrated, that the veins communicate with, and receive blood from, the arteries, which led anatomists to suppose, that the lymphatic vessels had a similar origin with the veins conveying red blood; and when the microscope shewed that an artery, and its corresponding vein, constituted one reflected tube, all doubt was removed as to the origin of the lymphatic vessels.

The opinion received great weight from anatomical injections; for a watery liquor, quicksilver, or melted wax, flows from the arteries into the lymphatic vessels, and from the fact, that the lymphatic vessels sometimes contain blood; hence the inference, that there were lymphatic arteries, and corresponding lymphatic veins, or that the lymph was circulated in a manner similar to the blood.

Such was the state of matters when my Father and Dr WILLIAM HUNTER took up a very different opinion. They have endeavoured to prove the lymphatic vessels to be unconnected with the circulating vessels, and to be absorbing vessels. To me it would be extremely painful to enter into the controversy which was so warmly carried on between Dr HUNTER and my Father, as to the merit of this discovery.

Considering, however, that the late Mr Cruikshank, and also Mr Wilson, have given the credit of it to Dr Hunter, I should be supposed to concede the right of my Father, if I took no notice of this point.

Mr Cruickshank's statement is, that "he (Dr Hunter) supported his claim so well, that those who were entitled to hold an opinion on the subject were on his side." But I apprehend there is, at least, equally strong evidence in favour of my Father's claim to this discovery.

The only evidence I shall at present adduce, is the letter of the celebrated Dr Black, which gives not only a very luminous and short exposition of the facts upon which his opinion is built, but also many circumstances decisive as to the claims of my Father.

"*Copy of a Letter from Dr Black, Physician and Professor of Medicine at Glasgow, to Dr Alexander Monro* jun.

"*Glasgow, 24th March* 1758.

"Sir,—In answer to your letter, in which you require of me to declare what I remember of an Essay of yours, which you allowed me to read before you left Scotland, I can freely declare that I read that Essay in September 1755; that the whole substance and design of it were, in every material point, the same with those of the Dissertation you have since published at Berlin.

"The design of it was, to propose and support a new opinion, with respect to the origin and use of the lymphatic veins, which was, *that they are a distinct system of vessels, having no immediate connection with the arteries and veins*, but arising, in small branches, from all the cavities and cells in the body, into which fluids are thrown; *and that their use is to absorb the whole, or the thinner parts, of these fluids, and restore them to the mass of circulating humours.*

"Your Essay contained an ample review of the opinions of different authors upon the same subject, and an examination of the experiments and observations from which such opinions have been deduced; in which you endeavoured to

shew, that these experiments and observations were, in fact, unfavourable to the common opinion, and tended to support that which you offered. You likewise observed, that the singular structure of these vessels, and their disposition in different parts of the body, were such as particularly adapted them to perform the office of absorbents. And added some experiments of your own, which pointed out their use to be of this kind, and were very unfavourable to the common opinion. I remember, likewise, that you had, for some time, been busily employed in anatomical experiments upon this subject, and shewed several preparations, which furnished arguments in support of your opinion. You had thrown quicksilver into the arteries, with such force as to produce extravasations, and from these the lymphatics were filled, either by the weight of the quicksilver in the arteries, or by a gentle agitation and alternate compression of the parts in which the extravasations were formed. You told me, at the same time, that an easy method of exhibiting the lymphatics, is, to fill the cells of the conglobate glands with air, which passes freely into such lymphatics as rise from them, to take course towards the lacteal sac.

" But the proofs which gave me the greatest pleasure and conviction, *were those deduced from some phenomena occurring in the practice of medicine, in which it is often observed, that where acrid matter is applied to the pores of the skin, or has access to the cells of the cellular membrane, as in the case of an ulcer, the neighbouring conglobate glands, which are between the parts affected and the centre of the body, are disordered with swelling and pain; manifestly from the matters being absorbed singly, or mostly by the lymphatics, and its being collected and allowed to stagnate, for some time, in the cells of these glands, into which the lymphatics empty themselves, and by its stimulus producing the disorder which follows.* The instances which you gave of this kind, were, I think, nearly or altogether the same with those adduced in your late Dissertation.

" The case of a blister applied to the head, and the instance of buboes in the venereal disease, are still fresh in my memory.

"I think I likewise remember the observations on inoculated patients; though I cannot be positive with respect to this or the other examples you have made use of. Upon the whole, your Latin Dissertation seems to me to contain the same matter, and that treated in the same manner, as the Essay I read in the year 1755. And, though you may have, no doubt, improved upon that Essay in your Dissertation, I must confess, I received as clear an idea of your doctrine, and as full a conviction of its truth, from that Essay, as I have received since.

"I am, Sir, your obedient humble servant,

"JOSEPH BLACK."

The lymphatic system has been described as consisting of the lacteal and lymphatic vessels; of conglobate glands connected with them; and the termination common to both, the thoracic duct. As the lacteal and lymphatic vessels constitute parts of the same system, and are similar as to size, structure, and function, I shall describe the whole under one head.

Of the Lacteal and Lymphatic Vessels.

The lymphatic vessels are very small, pellucid tubes, of different sizes, having thin, tough, elastic and flexible coats, and, from being provided with valves at short distances, have a jointed appearance. The lymphatic vessels are filled by a transparent fluid, which is slightly viscid, and contains, according to Mr BRANDE, a quantity of common salt.

The absorbent vessels are more numerous than the arteries or veins; their area is greater than that of the arteries and veins, and they are not peculiar to any one part of the body; for though they have not been seen in the human brain, spinal chord, organs of the senses, bones or placenta, yet there are arguments which prove their existence in such situations. The lymphatic vessels are not peculiar to man, they have been discovered in the mammalia, fishes, amphibia, birds, and insects.

The size of the human lymphatic vessels is not uniform,

and is not proportioned to the size of the individual, for they are proportionally larger before than after puberty, and they shrink in old age.

The lymphatics also, of different parts of the body, vary as to size in the same individual, and sometimes even in the different parts of the same limb: thus the lymphatic vessels of the head and neck, and of the arms, are smaller than those of the trunk of the body, or of the inferior extremities.

Those lymphatics which lie under the skin of the thigh and leg are more numerous, but smaller, than those which accompany the deeper seated arteries of the same limb; and those on the inner side of the limb are larger, and probably also more numerous, than those on the outer side of the same limb. The coats of those of the inferior extremities are thicker than those of the superior, or of the face.

Their size in man is proportioned to that of the body, for they have been observed to be much larger in giants, and smaller in dwarfs, than in persons of the ordinary stature. The lymphatic vessels, in their progress to the heart, become larger; thus those in the groin are larger than those of the foot.

In the horse, the lymphatics are larger than in man; but the lymphatics of the human body are as large as those of the ox or elephant.

When any part attains a large bulk, the lymphatic vessels are also enlarged; thus the lymphatic vessels of the gravid womb or of the mamma of a nurse are much larger than those of the virgin womb or mamma.

From the small size, thinness, and pellucidity, of the coats of the lymphatic vessels, it is difficult to discover these vessels. Much dexterity is also required in filling them, and afterwards in dissecting them.

After lymphatic vessels have been discovered, it is very difficult to open them in such a manner as to introduce proper instruments for injecting them; and as they are crowded with valves, which even in the dead body oppose the reflux of a subtle fluid, they must be filled from branch to trunk.

In dropsical persons the lymphatic vessels may be more

readily discovered than in others, because the fat in which they are imbedded has been absorbed,—because they are often filled by a watery fluid, and appear to be larger than natural, and, besides their coats, are by that disease frequently rendered opaque.

The lymphatic vessels of the superior or inferior extremities may often be seen by putting a ligature very tightly around the limb, and making pressure and friction on the skin beyond, so as to force the fluid in the cellular substance into the lymphatic vessels; they may be frequently observed in the hand, or at the wrist, when the light falls strongly on the part.

The lymphatic vessels are often filled, in consequence of the extravasation of a fluid thrown into the arteries with too great force. The fluid escapes into the cellular substance, and the lymphatic vessels connected with that part are filled.

Many of the lymphatics have been discovered in consequence of disease.

It is much more easy to discover and to preserve the lymphatic vessels of the intestines and mesentery, than those of other parts of the body. By feeding an animal with milk, and killing it in the course of two or three hours afterwards, and immediately opening the abdomen, the lymphatics may be observed between the layers of peritonæum which form the mesentery, provided a ligature be thrown around the root of the mesentery: thus the progress of the chyle is stopped, the lymphatics of the intestines are distended, and are distinctly seen; and by plunging the intestines and mesentery, when in this state, into good spirit of wine, the chyle will become white and opaque, and will be coagulated within its vessels.

The other way of discovering the lymphatic vessels, is to keep a part until it becomes putrid: the air generated by putrefaction distends the lymphatic vessels, which may afterwards be readily filled with quicksilver.

The course of the principal lymphatic vessels corresponds with that of the bloodvessels: the superficial set accompany the superficial veins, and the deeper set accompany the arteries.

The lymphatics often run parallel to each other; sometimes they are arborescent, and sometimes reticular.

Of the Coats of the Lymphatic Vessels.

The coats of the lymphatic vessels are thin and pellucid. There are two coats proper to these vessels, an external outer rough coat, by which they are connected to the neighbouring parts, and which bears a strong resemblance to condensed cellular substance, and an internal and very smooth coat, which is reflected to form the valves. These coats may be more readily shewn in the thoracic duct than in the inferior extremities, and more especially in that of the horse.

These coats are so thin as to be transparent, are remarkably tough, and capable of supporting a considerable column of quicksilver without rupture: indeed, I suspect that dropsy seldom or never arises from rupture of the lymphatics.

There are no fibres to be seen in the coats of the lymphatic vessels of man, but they may be seen in the thoracic duct of the horse.

The contents of the lymphatic vessels are very various, and depend upon those parts from which they take their rise.

The contents of the lymphatic vessels are rapidly propelled through these vessels; thus, if a lymphatic vessel be compressed, the chyle flows instantly onwards on the side next the heart; if we take off the pressure, the part of the vessel which was emptied will be almost instantly filled from the opposite direction.

Coagulable lymph forms a share of the contents of the lacteal and lymphatic vessels; hence, when one of these vessels has been wounded, the lymph forms a plug for the wound.

The lymphatic vessels are probably muscular; they are very irritable, more so than the arteries, and contract upon the application of a stimulus: those of young persons are most irritable, and have even been stated to contract after death: indeed, a muscular power is more necessary in them than in the arteries, as there is no *vis a tergo* to assist in propelling the lymph. The lymphatics possess what may be called a selective property, they admit some substances and reject others.

When the coats of the lymphatic vessels have been irritated, they become thick and hard, and appear as red lines upon the skin, which is probably owing to the inflammation and induration of the cellular membrane.

There are many small vessels proper to the coats of the absorbent vessels, which are of such a size as to admit the red globules of the blood, or the powder of vermilion: these are the vasa vasorum of the lymphatic vessels.

Many of the lymphatic vessels lie in immediate contact with the nerves; but these nerves, on account of their extremely small size, cannot be traced upon the coats of the lymphatic vessels.

Of the Valves.

The lymphatic vessels have numerous valves, which generally are disposed in pairs.

The valve is of a parabolic or semicircular form, connected with the inner coat of the vessel by its circular edge, and having its straight edge corresponding with the opposite valve loose in the cavity.

In some of the lymphatic vessels, the valves are disposed at uniform distances from each other, commonly about the distance of half an inch from each other, as in the spermatic cord, and in the lacteal vessels; but in others, they are disposed very irregularly, and in the great trunk of the lymphatic system, the thoracic duct, there are very few pairs of valves.

It is remarkable, that, in some instances, a few valves only are found in the trunk of a lymphatic vessel; while a number of pairs of valves are found in its branches.

The valves generally perform their office with great accuracy, so as even after death to support a considerable column of quicksilver. In filling them, the liquor must be thrown in according to the course of the lymph; I recollect of having heard of one instance only in the human subject, and that occurred to Dr William Hunter of London, in which a liquor could be forced through the lymphatic vessels of the extremities, in a direction contrary to the usual current of the lymph.

There are valves probably at the origin of the lymphatic and lacteal vessels, which prevent in the latter case an injection from being forced from the cavity of the intestine into the lacteal vessels.

The valves have been stated by some authors to render these vessels stronger; but if this opinion were well founded, they should be more numerous in the thoracic duct than in any other of the lymphatic vessels, as it contains the greatest quantity of chyle, and therefore is most apt to be ruptured; which is not the case. It is to be taken into account, that the greater thickness of the coats of the thoracic duct also tends to prevent the rupture of that tube.

The valves are intended to prevent the retrograde flow of the lymph; hence the pressure of the adjacent muscles, and pulsation of the neighbouring arteries, contribute to impel the lymph towards the heart; if there had been only a few valves in the course of the lymphatic vessels, external pressure would have had less effect in propelling the lymph onwards.

The valves in the lymphatic vessels of the liver do not perform their office so accurately as in other lymphatic vessels, so that the smaller branches of these lymphatic vessels may be filled from the larger.

A pair of valves is always found, where a lymphatic vessel terminates in the thoracic duct, or in a vein which conveys the red blood, to prevent the blood from flowing into the lymphatic vessel.

The lymphatic vessels of fishes have no valves, so that it is possible to fill the smaller from the larger branches; a circumstance which enabled my Father to discover the orifices of the lymphatic vessels upon the surface of the skin of the skate.

On the outer side of the valves of the lymphatics, there is a sac or pouch, similar to that which is found opposite to the valves of the veins which convey the red blood, whereby the lymph gets readily between the valve and the side of the lymphatic, to shut the valve.

In consequence of the valvular structure of the lymphatic vessels, they seem as if formed by the union of a number of cones.

Of the Glands connected with the Lymphatic System.

It is of much moment in practice to be acquainted with the situation of the lymphatic conglobate glands; for in this variable and changeable climate, they are very often swollen, from cold; and they are also liable to swelling from the absorption of various poisons, as that of lues venerea, cancer, fungus hæmatodes, &c.

The greater number of the lymphatic vessels are connected with these glands: some of these vessels are distributed upon the surface of these glands, but the greater number sink deeply into the substance of them; there are, however, some lymphatic vessels which are not connected with any of the glands: hence, though the gland be obstructed or diseased, the flow of the lymph to the heart is not interrupted.

The lymphatic glands are of an oval or rounded form, and are somewhat flattened. They vary as to size in different individuals: some in the healthy body are as small as a millet-seed; others equal a walnut in size, and, from disease, sometimes attain the size of an orange; and, where several of these glands are swollen, as often happens from disease, and are collected into one mass, they often constitute a tumour of a much larger size.

The lymphatic glands are generally much larger in the meridian than in the decline of life.

The colour of these glands varies, generally owing to the number of bloodvessels distributed on them. They are of a light red colour; but those in the vicinity of the liver have a yellow colour, from containing a proportion of bile; those in the mesentery are whitish, from being filled by a chylous fluid; and, at the division of the trachea into its branches, they are of a black colour. These glands are solitary, or disposed in groups: they lie under the skin, and are imbedded in the cellular substance which surrounds the superficial veins or the deeper seated arteries.

These glands are numerous in the side of the neck, axilla, and groin, in the pelvis, mesentery, and around the stomach

and pancreas, at the intercostal spaces, and at the division of the windpipe into its two great branches.

No lymphatic glands have yet been detected within the skull: I think I have seen the lymphatic glands at the side of the optic nerve swelled in a case of fungus hæmatodes, and in a case of cancer of the eye-ball.

No lymphatic glands have been observed in the hand or fore-arm, or in the feet and legs; and but one or two small glands have been detected on the surface of the trunk of the body.

The lymphatic glands are covered by a dense coat, of a grey colour, which has a shining appearance, and which is fixed down to the neighbouring parts by cellular substance, and upon this coat several small branches of arteries and veins are distributed.

Two different opinions have been entertained as to the minute structure of these glands.

My Father was led, from a careful examination of his preparations, to conclude that the lymphatic vessel which enters a gland, is subdivided within it into very minute branches, which form continuous canals, with very small branches of the lymphatics which issue out from the gland.

Nuck * has endeavoured to prove, that there is a good deal of cellular substance in the composition of the lymphatic glands which is included within a membrane; that the lymphatic vessels of the first order enter upon one side, pour the lymph into the cells, and, passing out from the opposite side, convey the lymph to the heart. Cowper entertains the same opinion as to the structure of these glands, of which he published figures.

My Father always denied the existence of cells in the glands connected with the lymphatics of the human body, and used to state, that, perhaps the appearance of cells was produced by uneven sections of the lymphatic vessels, or by the bursting of the vessels and effusion of the quicksilver, or other liquor employed, into the cellular substance.

* Vide Adenographia, p. 27.

He has stated that he discovered the structure of these glands by injections with wax and quicksilver, in a subject at Berlin, in the beginning of November 1756, in which the lacteal vessels were enormously enlarged where there was a hernia, in the same manner that the red veins become varicose, when the return of blood to the heart is not free.

In justice to Albinus, my Father adds, that he had been informed by Dr Reimarus, that this very ingenious anatomist proposed in his lectures nearly what he had described; but when my Father visited Albinus, he told him that he could not prove his opinion as to the structure of the lymphatic glands; it was only a conjecture.

In the larger quadrupeds, as the horse and ass, according to Cruickshank and Abernethy, cells are seen in the glands connected with the lymphatic system.

There are many bloodvessels distributed upon the external coat of the lymphatic glands, which serve probably not merely to form the covering of the glands, but also to secrete a fluid, which is mixed with the lymph in its progress through the glands.

We are still much in the dark as to the functions of the glands connected with the lymphatic system.

We cannot yet determine, for example, how far the mesenteric glands are subservient to nutrition.

Morgagni supposed that there was a muscular coat proper to these glands, for the purpose of propelling on the absorbed fluids, but this opinion is not supported by anatomy.

Dr Hendy supposed that the vessels of the conglobate mesenteric glands secrete a fluid, which tends to dilute the lymph. The lymphatic glands have been supposed to purify the lymph by straining it, and also to form the central parts of the red globules of the blood; but these are mere suppositions unsupported by any proof.

It has been matter of dispute, whether or not the lymphatic glands are supplied with nerves. Wrisberg has affirmed that nerves enter into, and are distributed upon, the substance of these glands; whereas Walter, in his Preface to his work on the nerves of the thorax and abdomen, has affirmed, that

no nerves are distributed through the substance of the lymphatic glands, but that they merely perforate them in their progress to other parts of the body.

Of the Origin of the Lymphatic Vessels.

I have already endeavoured to prove, that the lymphatic and lacteal vessels constitute parts of the same system, concerning the origin of which it is now proposed to make a few remarks; and as there has been, and still is, upon this point much diversity of opinion, I think it necessary to enter more at large into this subject.

It was supposed that the lymphatic vessels constitute a part of the circulating system, and this was by no means an unnatural opinion, as Dr HARVEY's discovery of the circulation was prior to that of the lymphatic system. The veins which convey red blood, were supposed to be the only veins of the body.

For a long period of time, this hypothesis gained credit, and seemed to be confirmed by experiments. Anatomists found, on opening living animals, blood *within the larger lymphatic vessels, and also in the thoracic duct*, which was supposed to afford complete evidence as to a connection between the arteries and the lymphatic vessels.

NUCK has also stated, that when he threw an injection with force into the splenic artery, he filled *vesiculas quasdam*, and also lymphatic vessels; and COWPER's experiments with the spermatic artery were followed by a similar result, and have been confirmed by RUYSCH. KAW BOERHAAVE affirmed, that water was absorbed by the mesenteric veins, and thus passed through the liver to the heart.

Dr MEKEL filled the lymphatic vessels of the different bowels of the pelvis, by filling their cavities.

The late experiments of M. MAJENDIE of Paris, lead to a similar conclusion, and especially the following experiments:

"M. DELILLE and myself separated from the body the thigh of a dog, that we had first laid asleep with opium, to prevent the pain inseparable from such an experiment; we left untouched only the crural artery and the crural vein,

which preserved the communication between the thigh and the trunk. These two vessels were dissected with the greatest care, that is to say, they were isolated to the extent of 15·75 inches; their cellular tunic was taken away, to prevent the concealment of the lymphatic vessels. Two grains of a very subtle poison (the Upas tienté) were then thrust into the foot: the effects of this poison were as rapid and as intense as if the thigh had not been separated from the body; they began before the fourth minute, and the animal was dead before the tenth.

"It might be objected, that, notwithstanding all the precautions taken, the sides of the artery and the crural vein still contained lymphatics, and that these vessels afforded a passage to the poison. To remove this difficulty, I repeated the preceding experiment upon another dog, with this difference, that I introduced into the crural artery the tube of a small quill, upon which I bound this vessel by two ligatures: the artery was afterwards divided circularly between the two ligatures, and the same thing was done with the crural vein; there was then no communication between the thigh and the body, except by the arterial blood that arrived at the thigh, and the venous blood returning to the trunk. The poison being then introduced into the foot, produced the ordinary effects, that is, death in about four minutes *."

The first point to be considered is, as to the channel through which, in the above experiments, the blood passed into the lymphatic vessels.

Was the blood effused in consequence of the inflammation, absorbed by the lymphatic vessels?

If this supposition be admitted, the lymphatic vessels are absorbents. That the red globules are occasionally absorbed is beyond doubt; as when, in consequence of an injury, blood is effused beneath the skin, the redness goes off, and the yellow colour of the serum remains after the red is

* Majendie's Physiol. translated by Dr Milligan.——Dr Mason Good, in Volume iv. p. 233. of his book on the Study of Medicine, has given some judicious observations upon this experiment.

gone. Or, observe what happens in slight inflammations, as in the eye; the clear vessels of the cornea are seldom dilated, so as to let in red blood; for, where red vessels are seen on the cornea, there is a new growth from the white part of the eye gradually extending over the cornea, but the original vessels do not admit of red blood.

When the eye has been inflamed, there is an effusion of the red blood into the interstices of the vessels of that organ; or it may be seen by the aid of a microscope, when an inflammation has been artificially excited in the web of the foot of a frog.

Blood, it may be observed, has been detected within the lymphatic vessels.

Bichat has made particular mention of two cases, in which the blood effused into the thorax had proved fatal, in both of which the lymphatic vessels were gorged with blood.

The experiments of Wepfer lead to a similar conclusion.

He gave to various animals a solution of the muriate of mercury; a violent inflammation was speedily excited, together with the effusion of a great quantity of blood into the abdomen, which was absorbed by the lymphatic vessels.

My father made experiments of a nature somewhat similar, and invariably found blood in the thoracic duct; and also when he excited violent inflammation by wounds.

With regard to the experiments of Nuck and Cowper, it may be observed, that, though mercury injected into the spermatic artery passed into the lymphatic vessels of the spermatic cord, but not into the spermatic vein, that is no certain proof of a continuity of vessels, otherwise the same would have happened during life; and as to Nuck's experiments, he having filled "vesiculas quasdam," shews that his injection had been extravasated into the cellular substance, from which it had been taken up by the lymphatic vessels.

It is well known to anatomists, that an organ may assume a red colour from a successful injection, without any of the injected fluid passing into the lymphatics of the part; but, if that organ be tender, and in a semi-putrid state, the

coats of the artery give way, the injection passes into the cellular substance, and into the lymphatic vessels, but not into the corresponding veins; and, by a careful dissection, the very place at which the injection had got out may be detected. With regard to the much celebrated experiment of MAJENDIE, above quoted, it may be observed, that the poison was insinuated into the cellular membrane of the animal's foot, and that, whilst the parts were injured, several veins must also have been torn and opened, into which the poison might have insinuated itself.

In the next place, it may be considered, whether the smaller branches of the arteries terminate in the lymphatic vessels, which seems, at first sight, probable. In addition to what has been above stated upon this much disputed point, it may be asked, What purpose can be served by such a distribution of vessels?

As the arteries divide into branches which receive the red globules, and also into branches which admit only the colourless watery part of the blood, why may it not be supposed that the veins begin in the very same manner? If lymph be necessary near to the heart, and in the large vessels, to give the proper fluidity to the blood, surely a greater quantity is necessary in its return towards the heart. Or, let us reason in another way; let us examine these organs where there is the least of the red colour in the body; do we find that the veins proper to these are proportionally smaller? They are equally large, and the lymphatics are by no means larger. There are instances where, without doubt, the watery part of the blood flows into the red veins, as in the eye. In the eye of a child, there are arteries proper to the crystalline lens that convey the red blood, but these afterwards become too small to admit the red globules. Or, let us observe what takes place in fishes, as in the cod, or skate. There are a few organs of a deep red colour, but all the rest are white. If here the arteries conveying colourless fluid returned their contents by colourless veins, the proportion of the red veins should be very small; whereas the same proportion is observed in these animals as in man.

The orifices of the lymphatic vessels have been supposed to be obvious to the naked eye, as at the caput gallinaginis, where, by blowing into them, they may be filled with air. Were this the case, gross substances would enter into our lymphatic system, that could not get through the circulating, but would stick in the extremities of the arteries. The case is this: It is the mouths of the mucous ducts of the urethra which are visible at the caput gallinaginis; and, when these have been filled with mercury or melted wax, being very thin and tender, and lodged in a very loose cellular substance, they readily burst, and the liquor, getting out at a hole in them, runs zigzag in the cellular substance, tears as it goes on, and at last gets into a branch of a red vein or lymphatic which has been torn, just as we fill the lymphatics of the testicle by bruising the part and forcing in the mercury, when it gets into the lymphatic vessels.

A strong argument against the opinion that the lymphatic vessels are absorbents, has been deduced from the non-discovery of lymphatic vessels in the brain. But the existence of such vessels might as well be denied in other places. Who has shewn them within the bones or placenta? The lymphatic vessels are rendered conspicuous by interrupting their course in living animals, which cannot be done in the brain, as the greater number probably are placed at the lower parts of it. There is strong proof, however, of their existence in the human brain *. The glands of the neck swell in the case of wounds and suppurations of the brain, and in hydrocephalus internus; and this would happen more frequently, if matter formed in the brain did not speedily produce fatal consequences. Conglobate glands are not found within the cranium, perhaps as they would have been unsafe there, from being liable to become swollen, when, by compressing the brain, they might have proved a cause of death.

It may be added, the lymphatic glands in the neck are as near to the brain as those of the groin are to the foot; they

* My Father has given many arguments in favour of their existence in the brain, in his book on that organ.

are also large, and more numerous than in the muscular organs; and, besides, the lymphatic glands of the neck are considerably larger than in the inferior animals, where the brain is smaller.

That lymphatic vessels are proper to the human brain is probable from analogy, for my father has discovered vessels of this description in the brain and organs of the senses of fishes.

Morgagni has described and depicted the lymphatic vessels of the human brain.

In short, there is no well grounded argument against the existence of lymphatic vessels in the human brain, and many strong arguments in favour of their presence.

Of the Manner and Cause of Absorption.

By what power do fluids enter the lacteal vessels? As the intestines are contractile organs, it may be supposed that the chyle is pushed into the lacteal vessels by that means. But pressure could have no such effect; besides, the liquors enter the lymphatic vessels under circumstances in which pressure can have no effect, as for instance within the bones.

If the abdomen of a living animal be opened, we observe that the contents of the lymphatic vessels pass into the thoracic duct. This cannot be the result of the pressure of the abdominal muscles; therefore, nothing but a contractile power in the coats of the lymphatic vessels could have pushed forward their contents. Fluids are sucked in, in the same manner as the fibres of the roots of plants imbibe nourishment, or by *capillary attraction*, as it has been called.

In the case of capillary attraction, the liquor rises the higher, the smaller the tube. But this power has only a certain effect, the fluid makes but little progress by its influence; another agent is necessary for propelling the fluid after it has thus entered the absorbent vessel, viz., the contractile power of the coats of the lymphatic vessels.

Nuck was the first author who maintained, that the lymphatic vessels had two coats. In the thoracic duct, these coats sometimes exhibit a fibrous structure, and though fibres be

not an infallible test of the presence of muscular fibres, it affords at least strong presumptive evidence of the fact, and when it can be proved that, to a fibrous structure is superadded a remarkable degree of irritability, we conclude with HALLER, that the lacteal and lymphatic vessels possessing these properties, are truly muscular, and, by that power, that the fluid which had entered by the influence of capillary attraction, is propelled upwards; and it has been proved, that the contents of the lymphatic system are propelled onwards even after death. The valves of the lymphatic vessels also contribute to the progress of their contents. If they had been destitute of valves, the progress of the included fluids towards the heart might have been interrupted. As the lymphatic vessels are valvular, when the muscles in their vicinity contract, the fluid is pushed onwards, for the valves impede the reflux even of so ponderous a substance as quicksilver; and it may be added, that the pulsation of those arteries which are contiguous to the lymphatic vessels, may contribute to the same purpose.

In short, the orifices of the lymphatic vessels are very irritable, and they in all probability possess a contractile power, which is propagated through these vessels by the stimulus of the chyle, and that contraction runs up the tubes, and the liquor is prevented from returning by valves.

This opinion accounts for all the phenomena of absorption. It explains why the lymphatic vessels absorb more at one time than at another; at one time, they are more irritable, and more excitable than at another, and sometimes the lymphatic vessels are indolent, because there is not the proper stimulus applied to them.

Why is the action of the lymphatic vessels on some occasions suspended? There may be various causes for that, and it may be added, that the lymphatic vessels are so circumstanced, as to be beyond the reach of the ordinary stimuli,—a circumstance which shews clearly, that they are incapable of being excited in the usual manner. It proves, that the action which the heart has on the bloodvessels does not extend to the lymphatic vessels, which must have been the case,

if they had had any communication with the sanguiferous system.

Having enumerated the circumstances hostile to the communication between the smaller branches of the arteries, or of the veins and the lymphatic system, and also those which render it probable, that absorption is not performed by the vessels of the circulating system, it remains to be considered whether the lymphatic vessels be absorbents.

Various circumstances are in favour of such an opinion.

The analogy between the lacteal and lymphatic vessels is complete in every circumstance.

The coats of both are thin, tough and transparent; both sets of vessels abound in valves; both pass through similar glands, while some of the vessels pass along their surface, and others pass through them, and both have one common termination in the thoracic duct. The lymphatic, like the lacteal vessels, begin by open mouths. There is no similarity between the veins which convey the red blood, and the lymphatic vessels. In the former there are few valves, but in the latter a great number. In the former, a few valves are sufficient to determine the fluid to the heart during the contraction of the muscles; but in the lymphatic veins, the push is wanting behind, more assistance is necessary; even the smallest pressure, whether of a muscle or artery, may assist in driving the fluid onwards. To give a practical proof of the effect of the valves, if a lymphatic vessel be filled with mercury, great care must be taken in handling it, as the slightest touch drives the mercury beyond the next pair of valves. As the lymphatic vessels, therefore, are better fitted for taking advantage of the pressure of the neighbouring organs, and as more pressure is required to push on their contents, we are led to conclude that they have a different origin.

It may be also remarked, that Majendie and Flandrin, who have denied that the lymphatic vessels are absorbents, admit that the chyle is absorbed by the lacteal vessels. It merits notice also, that there are many lymphatic vessels proper to the intestinal tube, which arise from its external and middle coats. These unite upon the mesentery with those ves-

sels which are properly called Lacteal, as they are filled by a milky fluid, and receive the chyle from the lacteal vessels. This shews clearly the similarity in the function of the lacteal and lymphatic vessels.

The resemblance between the liquors contained within lacteal and lymphatic vessels, and in those cavities from which they take their rise, is very striking. Those from the liver are filled with bile, those from the intestines with chyle, and those from the lungs with a black substance. Wherever the acrid matter of disease or medicine is absorbed, the lymphatic vessels in the direct course of the lymph become inflamed and thickened, and may in many instances be felt as cords under the skin, and the glands connected with these lymphatic vessels become swollen between the part and the heart. If a blister be applied to the neck, the conglobate glands between it and the heart swell; if the blister be applied higher than the inguinal glands, these are not affected; but if it be applied to the foot, *these glands generally swell.*

In like manner we can trace the course of the venereal poison.

The swelled gland or bubo is seated in the inguinal cluster, *very near to the tendon of the external oblique*, though the inferior cluster of inguinal glands be equally near to the place of infection, and they all receive the same nerves and circulating vessels; a circumstance which seems to me to admit of easy explanation, by supposing, *that the venereal poison is directly translated through the lymphatic vessels, into these particular glands, with which they are more immediately and primarily connected*, and in all the instances above enumerated, *the lymphatic vessels may be traced like the cords under the finger, running into or very near to the inguinal glands.*

For the same reason, if a nurse receives the infection from a child at the nipple, the glands of the axilla swell. If the axillary glands be swollen, the disease has probably originated from the child; but if the child has imbibed the poison from its nurse, the lymphatic glands around the mouth of the child are, in the first place, contaminated. In like manner, the glands of the axilla are often swelled, from dressing venereal

patients, if the surgeon has a scratch on his finger. If the mamma be cancerous, the glands of the same side become contaminated.

Further illustrations of the same truth might be adduced. Thus a scrofulous ulcer in the hand creates a swelling of the glands in the arm-pit. GALEN has made mention of histories of this kind, and calls the glands, when sound, *αδενοι*; when swelled, *bubones*.

There are other examples of a similar nature, and which afford strong arguments in favour of absorption by the lymphatic vessels. When a strong smelling pungent substance, as camphor, is applied to any part of an animal, it communicates its peculiar smell and taste to the lymph, within the thoracic duct; and even in the present day, when the tide of opinion is so strong in favour of absorption by the veins which convey red blood, the experiments of Drs LAWRENCE and COATS, which have been recently made *, have demonstrated, that a solution of the sulphat of iron, thrown into the abdomen of a cat, was not found in the blood, or other fluids, until it had made its appearance at the upper part of the thoracic duct.

CHAP. II.

OF THE DISTRIBUTION OF THE LYMPHATIC SYSTEM.

HAVING premised the above general remarks as to the origin, course, and structure, of the lymphatic vessels, it is now incumbent upon me to give a description of the particular parts of this system.

Of the Thoracic Duct.

The thoracic duct is formed chiefly by the lymphatic ves-

* Philadelphia Journal, August 1822.

sels of the inferior extremities, and by the lacteal vessels of the smaller intestines; and it is between sixteen and twenty inches long.

It varies in its size, course and termination, in different individuals. It is much larger in some individuals, at its origin, than in other persons.

This duct takes its rise from the receptacle of the chyle, an oval-shaped bag, which lies over the second and third vertebræ of the loins.

In this duct there is not the same number of valves as in other parts of the lymphatic system.

This duct sometimes follows a tortuous course, or it forms what have been called *Islands:* hence, though the principal trunk be obstructed, the flow of the chyle is not always impeded.

The thoracic duct frequently splits into two branches; one of which enters the subclavian vein, and the other the internal jugular.

The thoracic duct is firmly fixed down to the spine; it passes at first behind the aorta; it then passes a little to the right side, till it arrives in front of the first vertebra of the loins: it then perforates the diaphragm, behind its right crus, and in the posterior mediastinum: it is placed between the aorta and vena azygos.

The thoracic duct becomes gradually larger as it ascends from the seventh dorsal vertebra: in the chest the lymphatic vessels of the intercostal spaces, and which accompany the intercostal arteries, unite with it; and it receives also several lymphatic vessels from the lungs.

When the thoracic duct has ascended as high as the third or fourth dorsal vertebra, it passes obliquely over to the left side of the spine, behind the gullet, and beginning of the descending aorta, until it reaches the left carotid artery. It then ascends from the thorax, passing between the longus colli muscle and internal jugular vein, to the fifth cervical vertebra; and then descends and terminates where the internal, jugular, and subclavian veins are conjoined.

Of the Lymphatic Vessels of the Head and Neck.

The lymphatic vessels of the head are much smaller than those of the extremities of the body; and but few of them have been filled with mercury by the British anatomists. MASCAGNI, in his Plates XXIV. and XXVI., has represented a number of lymphatic vessels upon the upper-part of the head, the face, and also on the back-part of the head.

There are several lymphatic vessels which follow the course of the temporal artery, and which pass through small glands, connected with the parotid gland.

Some lymphatic vessels also accompany the occipital arteries, which enter a few small glands, situated behind the root of the ear, and the mastoid process of the temporal bones; and another cluster is placed at the nape of the neck.

The lymphatic vessels of the face lie in contact with the facial artery and vein; and those of the deeper parts accompany the internal maxillary artery, and pass through glands situated below the angle of the lower-jaw.

The lymphatic vessels of the eye-ball have not been demonstrated; but in diseases of the eye-ball, one or two small lymphatic glands have been observed at the side of the optic nerve. The lymphatics of the tongue pass into glands placed behind the angle of the jaw.

The lymphatic vessels of the human brain have been represented by MASCAGNI *; but they have not been seen by any other anatomist †.

The superficial and deeper-seated lymphatic vessels of the head pass downwards to the glands which are placed in the vicinity of the internal jugular and carotid arteries.

These glands are large and numerous, and collected into clusters; and have been named the *Glandulæ concatenatæ colli*. Some of these lie immediately under the skin, and near to the external jugular veins; but by far the greater number accompany the internal jugular veins and carotid ar-

* Vide his XXVII. Plate.

† The lymphatic vessels of the brain and organs of the senses of fishes were discovered by my Father, are mentioned in his book on the Nervous System, and are represented in his book on Fishes.

teries. The lymphatic vessels from these are joined by several lymphatic vessels from the deeper parts of the thorax, and unite into a lymphatic trunk, which, on the left side of the body, enters the thoracic duct, near to its termination; and, on the right side, goes into a small short trunk, called the *Duct* of STENO, which ends at the junction of the right internal juglar and subclavian vein.

A few of the lymphatic vessels sometimes open into the internal jugular vein, or into the subclavian veins, near to the junction of the internal jugular and subclavian veins.

Of the Lymphatic Vessels of the Superior Extremities.

There are two sets of lymphatic vessels, which are proper to the superior extremities; a *superficial* and a *deeper-seated set.*

The *superficial* lymphatic vessels are found on the fore and back-parts of the fingers and hands.

Those on the fore-part of the arm run upwards, directly on the fore-part of the arm; those on the back-part of the fore-arm are directed obliquely upwards, and towards the inner-side of the elbow-joint.

The lymphatic vessels continue their course upwards, along with the basilic vein; and some of these pass into small glands, in the vicinity of the humeral artery; but the greater number of these vessels do not enter into any gland until they reach the glands of the axilla.

There are also a few lymphatic vessels which accompany the cephalic vein; and, passing between the pectoral and deltoid muscles, are connected with some lymphatic glands, which are situated at the under-part of the clavicle.

The *deep-seated* lymphatic vessels, which accompany the branches of the arteries, accompany the radial, ulnar, and humeral arteries, and at length join the axillary lymphatic glands.

The greater number of the lymphatic vessels of the mammæ and lateral parts the chest, join with the axillary glands; and there are various branches which pass over the clavicles, and terminate in lymphatic glands at the bottom of the neck.

The axillary glands vary in size and number in different individuals; they are smaller than the inguinal glands, and they are imbedded in a considerable quantity of fat.

From the axillary glands, large lymphatic vessels pass beneath the subclavian muscle, and, by their union, form a trunk, which, on the left side of the body, leads to the thoracic duct near to its termination in the angle formed by the internal jugular and subclavian veins.

On the right side of the body, the trunk formed by the lymphatic vessels of the superior extremity, joins with the large lymphatic trunk, called the Trunk of STENO.

Of the Lymphatic Vessels of the Inferior Extremities.

There are two sets of Lymphatic Vessels proper to the Inferior Extremities, the superficial and deeper seated set; the former accompany the superficial veins, and are imbedded between the skin and muscles; the latter, which are by no means so numerous as the former, accompany the arteries.

The lymphatic vessels are larger, and more abundant on the inner, than on the outer, side of the thigh and leg; hence surgeons recommend mercury to be rubbed on the inner side of the thigh.

MASCAGNI has represented a much greater number of lymphatic vessels on the outer side of the thigh, than I have ever seen.

It may be also observed respecting the lymphatic vessels of the inferior extremities, that, in their progress to the under cluster of inguinal glands, they become somewhat larger, and very frequently and freely communicate with each other.

The superficial lymphatic vessels of the under part of the abdomen, and those of the loins, enter the inguinal glands; and some of the lymphatic vessels of the nates pass into the glands of the groin; but the greater number pass into the pelvis, along the gluteal and sciatic bloodvessels.

The greater number of these inguinal glands, is placed over the tendinous fascia of the thigh; a few of them lie under it.

The inguinal glands are not of the same size in all indivi-

duals, and they vary in number; sometimes we meet with only ten or twelve of them, but, on other occasions, with twenty, and even more.

These glands may be divided into an upper and under class; into those which lie nearest to the symphysis pubis, the lymphatic vessels of the external organs of generation enter, and these swell, or become buboes, in cases of cancer.

Of the Iliac and Lumbar Lymphatic Glands.

The lymph from the inguinal glands is conveyed by lymphatic vessels, which enter the abdomen under the crural arch, and follow the course of the iliac arteries, and hence have been called *Iliac Lymphatics*, the number of which is various.

The deeper seated lymphatic vessels which accompany the bloodvessels of the thigh, enter the pelvis through the small foramina in the membrane which plugs up the crural aperture.

From the iliac glands, the lymph is conveyed into the lumbar glands, which are placed upon the lumbar vertebræ, where the aorta divides into its two great branches, the iliacæ communes.

These glands vary much in different individuals.

The lumbar glands receive lymphatic vessels from the bowels of the pelvis, and especially from the bladder of urine and vesiculæ seminales, uterus and vagina.

There are a few lymphatic vessels, which, after having passed beneath the crural arch, pass along the prone muscles, and ultimately terminate in the lumbar plexus of the lymphatic vessels.

Of the Lymphatic Vessels of the Organs of Generation.

The lymphatic vessels of the testicle are large, and often numerous.

The lymphatic vessels are often to be seen on the outer side of the tunica vaginalis: these take their rise from it.

There are also many lymphatic vessels, which take their origin from the deep parts of the testicle, which may be generally filled, by making a puncture into the body of that organ, and by inflating them.

There are also lymphatic vessels, which arise from the rete testis, and from the epidydimis.

The various lymphatic vessels of the testes pass into the lumbar glands.

The lymphatic vessels of the scrotum enter the upper and inner inguinal glands; but those which are deeper, accompany the lymphatic vessels of the testicle, and end in the iliac glands.

There are two sets of lymphatic vessels proper to the penis.

Those that are superficial take their origin from the prepuce; unite and run chiefly upon the dorsum penis; and, at the root of the penis, they divide into right and left branches, which pass into the corresponding inguinal glands.

The deeper seated lymphatic vessels take their origin from the glans penis, and accompany the arteries of the penis into the under part of the pelvis.

The lymphatic vessels of the womb are rarely seen in the unimpregnated state. They follow the course of the bloodvessels, and pass into the iliac glands.

These vessels, like to the bloodvessels, are much enlarged from pregnancy.

The lymphatic vessels of the external organs of generation of the female, pass into the inguinal glands. The greater number of them pass through the inguinal canals, along with the round ligaments of the womb, and they ultimately end in the iliac glands.

The superficial lymphatic vessels of the lower part of the abdomen, and those of the loins, also pass into the inguinal glands.

The lymphatic vessels of the bladder of urine are not often seen; they follow the course of the veins of that organ, and pass into small lymphatic glands at the neck of the bladder, and ultimately into the iliac and lumbar glands.

Of the Lymphatic Vessels of the Intestines and Stomach.

The lymphatic vessels of the intestinum rectum, and of the greater intestines in general, are small, and are rarely seen,

excepting after putrefaction; for there is no great degree of absorption from the larger intestines.

It has been found in cases of stricture of the gullet, that life cannot be supported by nutritious clysters above ten or twelve weeks.

The lymphatic vessels of the smaller intestines are large and numerous; and being generally filled by a fluid like to milk, have been called *Lacteal Vessels.*

They are best seen in cases of sudden death, or by opening an animal a couple of hours after having given it milk.

There are two sets of lymphatic vessels proper to the smaller intestines; one of these is placed immediately under the peritonæum; the other takes its rise from the villous coat of the intestines, and are those vessels to which the name *Lacteal* may, with the strictest propriety, be applied.

These lacteal vessels, which take their origin from the villous coat of the intestines, are only seen by the sun's direct light, and by the aid of a magnifying glass; and when the arteries and veins of the intestines have been filled by injections of different colours.

The lacteal vessels take their origin by short radiated branches. They are collected into fasciculi, which have been called by LEIBERKUHN *Ampullulæ*, as he supposed them to be little bottles filled by chyle.

The lacteal vessels pass obliquely through the muscular coat of the intestine, and between the laminæ of the mesentery, and follow the course of the bloodvessels, and in their course unite into larger branches.

The superficial and deeper seated lymphatic vessels of the intestines freely communicate with each other, before passing between the laminæ of the peritoneum.

The lacteal vessels of the jejunum are larger than those of the ilium.

The lacteal vessels in their progress, pass through the lacteal or mesenteric glands, which are situated between the layers of the mesentery.

These glands are of various sizes, and they are not equal in point of number in all individuals.

In this country, these glands are very frequently much enlarged, and prove the cause of tabes mesenterica.

The number of the lacteal or mesenteric glands is very considerable; there is between 100 and 150 of them.

As the lacteal vessels of the jejunum are more numerous than those of any other part of the smaller intestines, so the glands connected with this part of the intestine are most numerous; and the greater number of these are situated on the left side of the mesenteric artery. In some places they are grouped together, and especially at the root of the mesentery.

The lacteal vessels which enter these glands, are called *Lacteals of the first order*, or *Vasa Inferentia;* and those which issue out of the glands, *lacteals of the second order*, or *Vasa Efferentia.*

The several lacteal vessels ultimately form two or three large trunks, which accompany the trunk of the superior mesenteric artery, and generally these open into the beginning of the thoracic duct, or they pass downwards, and join with the lymphatic vessels of the inferior extremities, and concur with them in forming the receptacle of the chyle.

The lymphatic vessels of the stomach are rarely visible in the sound body: they are small, as no chyle is formed in the stomach.

The lymphatic vessels of the stomach pass along its curvatures: some of them accompany the superior coronary artery, and in their course pass through small glands, situated at the juncture of the omentum minus with the stomach, and enter other glands, along with the deeper-seated lymphatic vessels, which end in the middle of the thoracic duct.

Those lymphatics which follow the course of the greater curvature, pass to the right, and partly to the left side, and join with the lymphatic vessels of the spleen and pancreas; others pass into glands near to the origin of the cœliac artery.

Of the Lymphatic Vessels of the Liver, Spleen, and Pancreas.

The lymphatic vessels of the liver are disposed in two sets; those that run on the surface, and those that are proper to the

interior of this bowel, and the latter are by no means so numerous as the former. They very freely and frequently communicate with each other.

The superficial lymphatic vessels of the liver follow an arborescent course, and are more easily filled than the lymphatic vessels of any other part of the body.

These superficial lymphatic vessels pass upwards towards the falciform ligament of the liver; they pass along this ligament and perforate the diaphragm directly, and then pass into small glands, placed upon the anterior part of the pericardium.

Some of the lymphatic vessels from the convex part of the liver, pass towards the lateral ligaments of the liver, and form two or three branches of considerable size, which perforate the lateral portions of the diaphragm, and afterwards run on that part of it which is next to the thorax following the course of the ribs; and some branches from them terminate in glands placed upon the gullet.

The lymphatic vessels from the lateral ligaments having joined with those from the falciform ligament, form a large plexus, which ascends between the layers of the anterior mediastinum, along with the internal mammary artery, and terminates in the upper-part of the thoracic duct.

The lymphatic vessels of the concave part of the liver are united to the deeper-seated lymphatic vessels of the liver, and they accompany the biliary ducts and bloodvessels of the liver, and pass through several lymphatic glands situated within the Capsule of Glisson, and terminate in the thoracic duct near to its middle *.

The lymphatic vessels of the spleen are very small in the human body, but in the inferior animals they are large and numerous.

There are two sets of lymphatic vessels proper to the spleen, a superficial and deeper-seated set; the latter accompany the arteries of that organ, join with those of the pan-

* Beclard supposes that absorbent vessels take their rise from the excretory ducts of the liver and testicle.

creas, and enter into the thoracic duct, nearly opposite to the origin of the cœliac artery.

The lymphatic vessels of the spleen, in their course, unite with the lymphatics of the stomach, and those descending from the under part of the liver, and form an intricate plexus; from which plexus, a number of lymphatic vessels pass off in different directions, some passing over, and others under, the duodenum: and, ultimately these lymphatic vessels terminate in the thoracic duct about its middle.

Of the Lymphatic Vessels of the Kidneys.

The lymphatic vessels of the kidneys are disposed in two sets, a superficial and a deeper-seated set. The superficial are spread over the kidney in a radiated form; and, generally, they may be observed covering the renal vein.

The superficial and deeper-seated lymphatic vessels of the kidneys unite at the thinner edge of this bowel, and form a plexus, which accompanies the renal arteries and vein, after which they enter into the lumbar glands.

The lymphatic vessels of the renal capsules end in the renal plexus of lymphatic vessels.

Of the Lymphatic Vessels of the Lungs and Heart.

There are two sets of lymphatic vessels proper to the lungs, a superficial and deeper-seated set. The former describe areolæ between the lobules of the lungs, or form a sort of network; and they pass into the bronchial glands, where they are joined by the deeper-seated lymphatic vessels, which accompany the branches of the trachea and pulmonary artery.

There are some of the absorbent vessels of the left lung which pass through glands behind the arch of the aorta.

The lymphatic vessels which have passed through the bronchial glands, form trunks, which ascend on the fore-part of the vena cava superior, and terminate in Steno's duct on the right side of the neck.

The lymphatic vessels of the human heart are very small, and rarely visible excepting in cases of disease.

The larger trunks accompany the coronary artery, and pass over the arch of the aorta to a gland placed behind the origin of the carotid arteries.

A lymphatic vessel of considerable size accompanies the left coronary artery: it passes into a gland placed behind the pulmonary artery and behind the arch of the aorta, and it joins with the lymphatic vessels of the lungs, which terminate in the upper-part of the thoracic duct.

From what has been stated as to the course of the lymphatic system, it follows, that this system terminates at the meeting of the left internal jugular and subclavian veins; and also in a small duct, which is about half an inch long, and which is formed by the lymphatic vessels from the right side of the liver, diaphragm, heart, and right lobe of the lungs, and by those of the right side of the neck and right arm.

It sometimes also happens, that a few lymphatic vessels open into the internal jugular, or into the subclavian vein, a short distance from the junction of these great veins.

In conclusion, I shall subjoin a very few general remarks upon the varied functions of the Lymphatic System.

The most important function of the lymphatic system is that *of taking up the chyle*, which supplies the waste of the body during the exercise of its several functions.

The lymphatic system also, by removing the solid and fluid parts of which the body is composed, and thus making way for the disposition of new matter, contributes to the growth of the body: thus the relative size, situation, and proportion of its component parts is preserved.

The lymphatic vessels *prevent the several cavities of the body from becoming dropsical, or the exhaled liquors from becoming acrid by stagnation.*

The several secreted liquors, as the mucus, the semen, the bile, &c. are at first much diluted, that they may be carried through the very small vessels. The lymphatics carry off the thinner parts of the secreted liquors, by which they are rendered more fit for their several purposes.

Many diseases are communicated by the lymphatics to the

system, such as small-pox, lues venerea, &c.; and, through this same channel, oil of turpentine, mercury, and other medicines enter the body. No one doubts that stimulating substances are absorbed, but many entertain doubts as to the absorption of a watery fluid, because there is no increase of weight after bathing. But this is not a well-grounded argument. It is no proof of non-absorption by the skin. There is a constant exhalation from the surface of the body; and hence, when there is not an increase in the weight of the body, we conclude that the exhalation and absorption have been equal. But there is, after bathing, in some instances, an increase of weight, proving an excess of absorption.

There are many instances of diabetes, in which the quantity of urine exceeding the whole ingesta, and also of dropsy returning, though the patient rigidly abstained from fluids of every kind, being apprehensive of a relapse,—of persons who, in consequence of stricture of the gullet, could swallow neither solids nor fluids, who suffered excessively from thirst, which was relieved by warm bathing, and who, after bathing, made as much urine as when in perfect health *.

By the lymphatic vessels, the progress of some diseases is removed; thus lymph that had been effused, is sometimes absorbed, and suppuration has been prevented.

By the same means, air, dropsical fluids, or blood collected under the skin, or within the shut cavities, and pus or blood contained within the lungs, have sometimes been removed by the absorbent vessels. The liver or spleen, when of an unnatural bulk, have regained their healthy size; and tumours upon the surface, or within the body, have been removed by the absorbent vessels.

Diseases in bones are also removed, or prevented from extending, by means of the lymphatic vessels. Thus, in the case of Necrosis, the old bone is sometimes removed by absorption, and that part of a bone which is diseased is cast off. The diseased bone acts as a foreign substance, and

* The experiments of Dr Rousseau of Philadelphia, seem to shew that absorption does not take place from the surfaces of mucous membranes.

proves a powerful stimulus; granulations shoot out from the living bone, and push off the diseased one.

The lymphatic vessels frequently remove diseased parts which are no longer useful in the animal economy, as aneurisms, after the flow of blood has been interrupted through these by a ligature.

The opaque and diseased crystalline lens, when depressed, is removed by absorption.

The communication between the various parts of the lymphatic system, is a safeguard against the effects of disease.

By means of the various anastomoses between the different lymphatic vessels, there is little or no chance of the progress of the lymph being wholly interrupted; in proof of which, a swelling of several of the inguinal glands rarely produces œdema.

If there had been no communication between the lacteal vessels, the progress of the nourishment into the blood must have been frequently interrupted, owing to the enlargement of one or more of the mesenteric glands.

The acrimony of disease is much blunted by the lymph added by the conjoined absorbent vessels; hence buboes within the cavities of the body are comparatively rare: the matter of disease is thus diluted and rendered less irritating.

The knowledge which the physician possesses of the origin and structure of the lymphatic vessels, suggests to him the important benefits resulting from friction and pressure, when the action of the lymphatic system is torpid.

Celsus has highly extolled the rubbing oil on the belly, in cases of dropsy, in which all succeeding authors agree with him.

The observations made upon the beneficial effects of friction, in cases of dropsy of the belly, or of general dropsy, apply also to buboes, and venereal nodes: these have often thus been dissipated. Blisters are also extremely useful, when the action of the absorbents is languid, and they prove useful in removing buboes and nodes.

The greater number of lymphatic vessels, which take up irritating substances, the infectious matter of disease, and va-

rious poisons, in their progress within the heart, pass through certain glands, which they divide into branches. Hence these glands are liable to many diseases.

There is a possibility that the constitution may be deeply contaminated by the venereal poison, though there be no bubo, because all the lymphatic vessels do not enter the gland. Fallopius observes, that, in his time, *solet oriri bubo absque gonorrhœa et absque carie.*

From the condition of the lymphatic glands, we may conjecture whether a tumour remains in an inactive state, or whether acrid matter be generated within it. Thus, in the case of scirrhous mamma, if the lymphatic glands of the axilla be swollen, it is probable that cancerous matter has begun to form in the diseased breast.

It often happens, that, though cancer has begun in the mamma, which has given rise to a swelling of the glands in the axilla, yet, owing to the quantity of fat, the swelling is not to be discovered by the feel through the sound teguments.

It is possible, from the situation of a venereal bubo, to judge whether the disease is in its progress inwards or outwards. For instance, a bubo, the consequence of chancre, is placed near to the tendon of the external oblique, the matter being only in its passage towards the blood; but if a gland at the under part of the inguinal cluster, be swollen, this is a proof of the system being deeply contaminated, for it must proceed from a venereal ulcer in the leg.

By the lymphatic vessels, medicines are introduced into the blood, and thus disease is sometimes prevented or cured. In the treatment of many diseases, it is of much moment that the medicine should reach the seat of the disease; that it should follow the same route as the poison; hence the greater benefit from mercurial inunction upon the thigh, in case of bubo, than of the mercurial pill.

Diseases are also occasioned by a want of the due action of the lymphatic vessels. Dropsy often proceeds from debility, and want of the healthy action of the lymphatic vessels; or the body is imperfectly nourished, from an obstruction of the

mesenteric glands: a sufficient quantity of chyle does not pass into the blood.

Diseases also arise from an over action of the absorbent vessels. Even the most solid parts of the body are in this manner removed. Thus the pressure of an aneurism of the aorta, gives rise to the absorption of a part of the breast-bone; or the same disease in the descending aorta, produces the same effect upon the spine; or a tumour upon the head occasions an absorption of a part of the skull; or, on some occasions, so much of the earth of the bones is removed, that the bones become so soft and flexible, as to be incapable of supporting the weight of the body.

Lastly, As the lymphatic system terminates on the right side of the heart, all the matter which is absorbed, whether from the surfaces or substances of the several organs of the body, is brought to the lungs before it can reach the other parts of the system; and even the matter which is absorbed from the lungs is directly returned upon them by their own lymphatic vessels. Hence the lungs are, more than any other organs, exposed to disease.

From what has been stated as to the structure, origin, course, anastomoses, and terminations of the lymphatic system, the following inferences may be drawn.

That the branches of the lymphatic vessels do not communicate with the smaller branches of the arteries, or of the veins, and probably exist in all parts of the body.

That they are greater in number than the arteries or veins.

That the lymphatic vessels constitute the only system of absorbents; and the strongest proofs they are so, are,

1. Their analogy to the lacteal vessels:

2. The fluid they contain being similar to the fluids in the cavities from which they take their origin:

3. The inflammation and thickening of the coats of the lymphatic vessels, and of the glands connected with this system, consequent to the absorption of acrid poisons; and,

4. The existence of the lymphatic system in the mammalia, birds, amphibia, fishes, and insects.

That the process of absorption is continually going on, and bears a ratio to the activity of the secreting vessels.

That the lymphatic vessels take up the solid * as well as the fluid parts of the body.

That the absorbent system has a great share in carrying on several of the more important functions of the animal economy.

That, from the peculiar functions of this system, it is the medium through which the contagion of disease enters into the blood; and hence that an intimate acquaintance with the origin and course of this system cannot fail to pave the way to many improvements in the practice of medicine and surgery: it may suggest the means of preventing contagion from being communicated,—of exciting these vessels to their healthy action when they become torpid,—of arresting the course of poisons in their progress to the blood,—and also of applying an antidote in the manner which is most efficacious, for mitigating or destroying those poisons which have already contaminated the constitution †.

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* Vide Observations of my Father on the Absorption of Solids, in his Treatise on the Brain. Edin. 1797. Dr Winterbottom, who had been the pupil of Mr J. Hunter, in his thesis De Vasis Absorbentibus, Edin. 1781, has observed: "Absorbentia, fluida sorbere, jamdiu notum; gloria autem monstrandi ea solida quoque haurire, penes Monro Anatomicum peritissimum est. In hanc sententiam, uti jamdudum in Prælectionibus prædicavit, multis argumentis adductus ibat: Sed præsertim, quia thymum glandulum evanescere; ossa senis multo leviora quam juvenis esse; terram rubram, quam rubia tinctorum in ossa infert, post aliquod tempus auferri; etiamque variis in morbis ossa mollia, distorta, fere pellucida, et levia, devenire; imo, aliquot in exemplis, insolitam quantitatem sedimenti albidi, terræ ossium simillime, in urina fuisse inventam,—animadvertit."

† I regret very much, that want of room precludes me from describing the lymphatic system in birds, the amphibia, and fishes. I beg to refer the reader to my Father's book on Fishes, who discovered, and has fully described, the lymphatic system in the above classes of animals, and in the echinus marinus,

PART VIII.

OF THE GRAVID WOMB AND ITS CONTENTS.

CHAP. I.

OF THE STATE OF THE UTERUS AT THE NINTH MONTH OF PREGNANCY.

THE Contents of the Pregnant Womb are, the fœtus, liquor amnii, placenta, membranes, and umbilical cord.

The placenta and membranes line the womb, and contain the fœtus, and the liquor amnii.

Of the State of the Uterine Tubes at the Ninth Month.

The uterine tubes do not pass horizontally outwards, as in the virgin state, but are closely applied to the uterus; are also larger, redder, less convoluted; exhibit more distinctly a muscular structure; and the internal rugæ are more distinct.

Of the State of the Ligaments of the Womb at the Ninth Month.

In consequence of the extension of the womb, the broad ligaments in a great measure disappear; for little more than the roots remain.

The round ligaments are much enlarged: their arteries become tortuous, and anastomose with the external vessels of the groin.

The round ligaments pass downwards on the fore-part of the body of the uterus, and are considerably larger, and more vascular, than in the virgin state; and the bloodvessels proper to these anastomose with the external vessels of the groin.

Of the State of the Womb at the Ninth Month.

The womb, in different women, at the ninth month, is different in point of size, and even differs in the same woman in different pregnancies, which depends upon the bulk of the fœtus, and the quantity of liquor amnii.

The womb generally inclines to one side, and rests on the os ilium.

The substance of the womb is unlike any other part of the animal body; it is soft, loose in its texture, plastic, and readily impressed by any harder body, with which it comes into contact.

This laxity of texture seems to be connected with the large quantity of cellular substance, and the number and size of the bloodvessels and lymphatics, which are proper to it. The greater part of the substance of the uterus is composed of small muscular fibres, the course of which it is impossible to trace upon the outer surface of the womb.

The course of these muscular fibres has been very differently represented by authors. Malpighi represents them as forming a net-work. Ruysch says, the muscular fibres of the womb form an orbicular muscle, and resemble concentric fibres. Dr Hunter has represented the muscular fibres of the womb as being transverse in the body of the womb, and as describing concentric circles around each orifice of the Fallopian tubes.

These fibres possess the distinguishing property of the muscular fibre; a contractile power which, according to Dr Hunter, is in some parts of the womb voluntary, but in others involuntary; and in some places slow, but in others quick. Owing to the softness of the muscular structure of the womb, which is not put upon the stretch by the contained parts, the womb very readily changes its shape from a particular posture, from the pressure of adjacent parts, or from the position of the fœtus.

The gravid womb is placed somewhat obliquely, the fundus lies forwards, and the mouth is directed backwards; hence the intestines must always be placed behind the uterus.

The mouth of the pregnant womb is widely different in appearance from that of the unimpregnated womb. At the ninth month it is flat; and there are a number of cavities on its inner side, containing a viscid jelly, which completely plugs up the mouth of the uterus. When delivery has commenced, this jelly is detached.

This viscid gluten is discharged along with the liquor amnii, and exhibits a distinct cast of the lacunæ of the orifice of the uterus, within which it had been lodged.

The arteries of the uterus, at the ninth month, are very large and numerous, and freely communicate with each other, and upon the inner-side of the womb they are remarkably tortuous.

The veins of the womb follow the same course as the arteries; are considerably larger than the arteries; and, on account of their great size, have been named, by some anatomists, *venous sinuses.*

The lymphatic vessels of the uterus increase as much as the bloodvessels of that organ, in consequence of pregnancy, and are about the size of a common writing-pen. They are very numerous, and form a plexus over the greater part of the substance of the womb.

Of the Membranes or Secundines at the Ninth Month.

The placenta and membranes form a complete bag, which contains the fœtus and liquor amnii.

At the ninth month, we meet with three membranes only; the amnion, chorion, and decidua.

The membrane next the fœtus, called *Amnion*, is very thin and pellucid; but in texture firm, and not readily torn. It lines the placenta; is reflected on the umbilical cord, and terminates at the navel; and is united to the chorion by means of a gelatinous substance.

The membrane on the outer side of the amnion, called *Chorion*, is thicker than the amnion in some places, and nearly transparent; and, in the earlier stages, exhibits a flocculent appearance, being covered by a number of small vessels. It is fixed to the amnion by a jelly. The chorion gives a co-

vering to the placenta and umbilical cord, and adheres pretty firmly to it.

The third membrane lines the uterus, and falls off at every delivery; and has hence been called *Decidua.* It is very easily torn, though thicker than the amnion or chorion; and there are a number of small vessels proper to it, which contain red blood.

Of the Liquor Amnii.

The fluid contained within the amnion, has been called *Liquor Amnii.*

This fluid, which varies in quantity in different women, has no sensible degree of tenacity; is nearly transparent; has a slight yellow tint; and sometimes reddish, from an admixture of a few drops of blood; is to the taste salt, and is composed of

Water, about - -	98.8
Albumen, muriate of soda, soda, phosphate of lime, lime, - - -	1.2
	100.0

In some cases, there is a small quantity of water between the chorion and amnion, which is commonly discharged before the birth of the child.

This fluid renders the pressure on the body of the fœtus more equal, and prevents the womb from pressing on any part of the fœtus. Hence when an officious midwife draws off the waters too soon, the child is sometimes killed, by the contraction of the womb stopping the circulation of the blood in the umbilical cord.

By means of the liquor amnii, the uterus is equally extended in all its dimensions, and hence the growth of the body of the child is not interrupted.

The liquor amnii renders the fœtus lighter. If the specific weight of the fœtus be to the liquor amnii as 20 to 19, the fœtus makes a pressure on the uterus equal only to the $\frac{1}{20}$th part of its absolute weight; therefore there is less chance of the fœtus interrupting, by its weight, the flow of blood

through those vessels which form the connection between the mother and child.

The protrusion of the membranes, distended by the liquor amnii, by gently dilating the os tincæ, facilitates delivery.

Of the Navel-String, or Umbilical Cord.

The umbilical cord, the medium of connection between the placenta and child, is not uniform as to thickness and length.

It is generally thinnest next the placenta, and about two feet long; but, in some cases, does not exceed a foot, and in others is four or five feet in length; and sometimes makes two or three turns round the child's neck. The umbilical cord consists of two arteries and a vein, and a thick jelly, all of which are enveloped by the chorion and amnion.

The arteries and vein of the cord are disposed in a spiral direction. In some very rare instances, there is only one artery.

Sometimes the umbilical arteries are not disposed in the usual manner, but follow a straight course, and then form a sort of knot, one of the arteries being longer than the other.

Owing to the thick jelly which envelopes the arteries and vein of the umbilical cord, and the spiral course of its arteries, pressure, or the stretching of the navel-string, does not readily interrupt the flow of blood through the bloodvessels.

The umbilical cord is not fixed to the middle of the placenta; hence the placenta is more readily detached.

Of the Placenta, or After-Birth.

The placenta is a flat organ; to the touch spongy; in form nearly circular; and about an inch in thickness in its centre, when its vessels are distended; it is generally attached to the fundus uteri.

The placenta towards its circumference becomes gradually thinner; and, when fixed to the uterus, is concave next the child, and convex towards the womb. The surface of the placenta, which is attached to the womb, is very tender, and lobulated.

The umbilical cord is not attached exactly to the centre of the placenta, but rather nearer to its edge; and from the umbilical cord, the vessels spread out upon the surface of the placenta, from which they pass into its substance.

The large umbilical bloodvessels are disposed on that part of the placenta which is next the child; and on the side next the uterus, bloodvessels may be observed passing between the placenta and uterus.

The placenta, when divided, seems to be composed chiefly of bloodvessels, which are distributed through it in all directions.

By filling the vessels of the placenta, it becomes about two inches thick; and if the injection be thrown into the arteries of the mother, called *Uterine*, the injection fills only one-half of the placenta, as that organ *consists of two distinct parts*, which do not communicate with each other, and between which, are cells that are filled by throwing a penetrating injection into the arteries or veins of the uterus.

These fœtal and maternal parts of the placenta may be separated from each other, by steeping it for some time in water, until a slight degree of putrefaction has begun.

The structure of these distinct parts is not precisely the same; the portion called *fœtal*, bears a strong resemblance to the lungs, and the arteries of that part terminate in the veins; but in the *maternal part*, cells are said to be interposed between the smaller ramifications of the arteries and veins, and the cells of the whole placenta freely communicate with each other.

In the case of twins, there are sometimes two placentæ, each of which is as large as when there is one child only. These are united only by the membranes, and by small vessels, which cannot be filled by the coarse injection.

But, in other instances of twins, the two placentæ resemble one placenta, divided into two parts by the reflected membranes. Dr Reid has in his possession a specimen, in which the vessels of the umbilical cord divide into branches upon the membranes, before they reach the placenta.

The branches of the umbilical arteries distributed on the

different lobes of the placenta, do not communicate with the arteries on the contiguous lobes; in which circumstance, the distribution is similar to that of the renal arteries.

CHAP. II.

OF THE STATE OF THE WOMB IN THE EARLIER MONTHS OF PREGNANCY.

THE womb is not completely filled by the child, and hence assumes various shapes from accidental circumstances. The bony brim of the pelvis, and sometimes the psoæ muscles, make an impression on the womb.

The ovum consists of the membranes which contain the fœtus and liquor amnii. At this early period, there is no umbilical cord; the fœtus adheres to its membranes.

There are four membranes in the earlier months, the *amnion*, *chorion*, *decidua*, and *decidua reflexa*. The two former are proper to the fœtus; in proof of which, when the fœtus is lodged in the Fallopian tube, it is enveloped in these membranes, and the two latter to the womb.

A part of the decidua is reflected, forming the fourth covering. Dr HUNTER has particularly described this reflection.

The fœtus passes into the uterus, inclosed within the ammon and chorion, which has a great number of shaggy vessels upon it.

The chorion is considerably thicker in the earlier than in the more advanced stages of pregnancy, and is covered by flocculi of different lengths and thicknesses, which in a short time disappear, excepting in the upper part, where they contribute to form the placenta.

Between the chorion and amnion, which cover the umbili-

cal cord, there is a bag of an oval form, called *vesicula alba*, filled by a fluid. It is placed about an inch from the insertion of the navel-string into the placenta.

The vesicula alba is found only at the commencement of pregnancy.

The quantity of the liquor amnii, is proportionally greater in the first than in the latter months of pregnancy.

When the fœtus is very young, it is in immediate contact with the membranes, but by degrees it recedes; and it is connected to the placenta by the umbilical cord.

The umbilical cord is at first very short and flat; at the period of birth it is commonly about two feet long. The length and thickness of the cord vary in different individuals.

The *urachus* constitutes a part of the umbilical cord: it ascends from the fundus of the bladder, and is inserted into the navel-string.

The uterus rapidly increases in size, in consequence of the determination of blood to it.

The difference in the size of the uterus, at the same period of utero-gestation, is considerable in different women; it depends on the size and number of the fœtuses, and also on the quantity of liquor amnii.

The uterus does not rise so much, as to be sensibly felt above the ossa pubis, till after the fourth month of pregnancy.

The fundus uteri is in the first place distended, and then the neck of that organ.

The mouth of the pregnant uterus is directed backwards, so that the axis of the uterus corresponds with that of the pelvis.

At the fourth month, the womb measures about five inches from the fundus to the beginning of its neck.

At the sixth month, it extends about four inches above the pubis.

At the eighth month, the uterus reaches half way between the navel and sternum; and, at the ninth month, it reaches as far up as the ensiform cartilage of the sternum.

The above measurements are not invariably the same;

they vary a little, from the differences in the stature of different women, the size of the fœtus, and the quantity of liquor amnii.

Of the state of the Fœtus in the earlier months of Pregnancy.

Sir E: Home discovered an embryo on the seventh or eighth day of pregnancy, before it was attached to the inner membrane of the womb. The following is on extract from the description of it given by Mr Bauer.

" On closely examining the subject under the microscope, I found it consisted of membrane, which, considering the extreme minuteness of the object, is of considerable thickness and consistence, very little transparent, quite smooth, and milk-white, forming a kind of bag of an irregular shape, not quite $\frac{19}{200}$ parts of an inch in length, and in its middle about $\frac{9}{200}$ parts of an inch broad. On one side it has an elevated ridge, or loose fold along the whole length, and on the opposite side it is open nearly to the same extent, but has no appearance of being torn; the edges of the membrane being smoothly rolled inwards, which gives it much the shape of a little shell of the genus voluta. When laid on glass, the membrane admitted of being laid open on both sides by the point of a fine camel-hair pencil: when thus opened, I found it contained another smaller bag, somewhat less than $\frac{16}{200}$ parts of an inch long, and not quite $\frac{5}{200}$ parts of an inch broad, ending at the upper extremity nearly in a point, but the lower extremity was very obtuse, and in the middle it was slightly contracted."

By the seventh week, the fœtus has been stated to be equal to a bee in size; and, about the eighth week, to be as long as a kidney-bean, and in form to resemble two ovals of unequal size, joined by a neck.

Baron Haller bestowed great pains in order to discover the growth of the fœtus in utero at different periods.

He has stated, that it increases during the first month to a bulk 300,000 times greater than its original size; during the second month, the increase is forty-eight times the size it had at the end of the first; from which time, to the ninth month,

there is, at an average, an increase of fifteen times for each month.

The younger the fœtus, the greater the proportion of the head to the trunk. The fœtus does not increase in size in proportion to its age.

In the second month, it has been said to grow more slowly, in the third more quickly, in the fourth more slowly; but from the middle of the fourth month to the sixth, it grows more rapidly; and between the sixth and ninth month, more slowly.

The embryo in the first and second month is a little bent. In the fourth and fifth, from the addition of its extremities, it seems folded up.

After the second month, the head grows more slowly. The face, in a young fœtus, bears a small proportion to the brain-case.

The fœtus at first seems to have no neck. It weighs only about ℈ 1.

The eyes appear at first like black circles: before the third month, the eye-lids are either open, or so thin, that the eye-ball shines through them.

There are little pores in the situation of each ear about the ninth week: but the external ears are not complete until the fifth month.

About the eighth week the nose appears.

Two small apertures may be observed at first, and it is complete about the twelfth week.

The mouth is large at first, and is visible about the seventh week, but not the lips; they begin to be formed about the tenth week, and at the twelfth, are quite distinct.

The organs of generation are manifest at the fourth month.

In the fourth month, the fœtus is about five inches long.

In the fifth month, the fœtus is about six or seven inches in length.

In the sixth month, the fœtus is eight or nine inches long, and perfect in its shape and formation. The parts of the eye are formed, and the pupil is covered by a membrane, called

membrana pupillaris. The skin then hangs loosely on the body, which gives it a shrivelled appearance.

In the seventh month, it is eleven inches.

During the last three months, the fœtus grows rapidly, and it gains more proportionally in breadth than in length.

About the sixth week, the limbs begin to grow and appear like little buds. In the second month, they are a little elongated; and about the beginning of the third month, or a little after, the fingers and toes are formed.

Professor Sœmmering has remarked, even in the fœtus between the third and fourth month, the greatest difference in the thorax of the sexes; that the male is not only longer and more conical, but also much more prominent in respect to the abdomen and pelvis, than the female.

The female chest is not only shorter, but also wider above the fourth rib; below, it is more contracted, and therefore less conical; and it is also farther distant from the pelvis, as a greater space intervenes between the last rib, and spine of the os ilium.

He observes, that the form of the head of the male differs from that of the female: it is larger in proportion to the whole body, less rounded, more prominent behind, and flatter in the crown. He also remarks, that the arms of the male are a little longer than those of the female; the fore-arms fuller, and the scapulæ larger and more prominent.

According to Sœmmering the inferior extremities of the male are more contracted, and the thighs are more slender.

At the 4 month, the fœtus is equal to 5 inches in length,

6		8 or 9 inches long,
7		11 or 12
8		15
9		20 according to Roederer.

The female is rather less than the male, and when there are twins each fœtus is commonly much less than when there is only one child.

Males are larger than females, and the head is in circum-

ference greater, and hence it has been stated by Dr CLARKE *, that a greater number of male than of female infants die during birth.

Till the sixth week, the belly of the fœtus is in contact with the placenta.

About the eighth week, the umbilical cord is nearly an inch long.

Dr CLARKE of Dublin endeavoured to ascertain the average size of the head of male and female children at the full time. The longest diameter is from the crown to the chin, and it is about five inches. The breadth of the head from the one parietal protuberance to the other, is $3\frac{1}{2}$ inches.

Dr CLARKE measured the heads of a hundred and twenty children, born at the full time, and found the circumference passing through the occipital protuberance and the middle of the os frontis, to be at an average 13.8 inches; and across the top of the head, from ear to ear, 7.32 inches. The mean weight of the fœtus, at the natural period of birth, is about seven pounds avoirdupois. Dr MACAULAY, during his long practice, weighed several thousand new born and perfect children; the smallest was 4 lb., the largest 11 lb. 2 oz.

Dr CLARKE has observed, that the average weight of twelve twins was five pounds and a half each; and twins are are not only smaller, than in the case of a single child, but weaker, and more disposed to disease.

Calculations have been made as to the proportions of cases in which there are twins. Dr CLARKE has observed, that in the Dublin Hospital, 1 in 58 had twins, and in the British Lying-in Hospital, 1 in 91. Triplets, according to CLARKE, do not occur in above 1 out of 5000 cases.

In the preceding parts of this work, the anatomy of the several bowels of the fœtus has been given; and Plate X. gives a more impressive idea of the relative situation of the bowels of the thorax, abdomen, and pelvis, than language can communicate. It shews the situation of the heart and lungs of the fœtus; the flatness of the diaphragm; the greater size of the abdomen than in the adult, the greater size of the liver,

* London Phil. Trans., vol. lxxvi.

which occupies a larger space in the abdomen, and the small size of the pelvis at that early period of life.

On recurring to the description of the intestinum rectum, I observe that I have omitted to describe the course of the rectum of the fœtus, which, as far as I know, has not been described with sufficient accuracy. This bowel in the fœtus is proportionally smaller than in the adult, and more especially in the vicinity of the anus. It follows the same course as the rectum for a certain way only, as far down as the third piece of that bone; from which place it makes a semicircle, the convexity of which is forwards, or the lower part of the rectum keeps the opposite course from the same bowel of the adult.

From the preceding description of the contents of the Pregnant Womb, as given in Chapters I. and II., the following inferences may be drawn, regarding the various causes of death of the fœtus, when no blame can be attached to the mother.

These merit attention, from their more immediate reference to the study of Forensic Medicine.

In the *first* place, Experience has shewn, that children born before the fifth month are not born alive; and also, that children born before the seventh month seldom, or never, arrive at maturity.

2d, There are some fœtuses so formed as to be incapable of an independent existence; of this denomination are various monsters, born without a head, &c. &c.

In the *third* place, The fœtus may be destroyed by diseases which occur to the mother during her pregnancy, or by diseases incident to itself.

When the fœtus is feeble or delicate, it often dies as soon as it is born.

I have met with several instances, in which children were born with water in the head; some of the patients survived

but a few hours, whereas others lingered under the disease for two, four, ten, or even twenty, years. There are many instances of children being born dead who bore all the marks of the venereal disease.

The fœtus in utero has also been attacked with small-pox, in consequence of the mother having been exposed to the contagion of that disease.

In the *fourth* place, The fœtus in utero may die from the partial or total separation of the *placenta*, and in these circumstances it appears bloodless, and like a piece of wax; and when examined after death, the bloodvessels appear empty.

5th, The ossification of the placenta is a cause of great debility of the fœtus, or of its death. I have had occasion to meet with three instances of this organic derangement of the placenta, and they occurred during the successive pregnancies of the same woman; the children, though weak, survived; and the woman had afterwards four healthy children, and the placentæ were quite natural.

6th, The child may be destroyed by the twisting of the umbilical cord round its neck. In these circumstances, the circulation through the blood may be impeded by the action of the womb; or, by the stricture of the cord upon the neck, by which the return of the blood through the jugular veins of the child may be impeded. In such a case, there is an ecchymosis round the neck.

7th, By a rupture of the umbilical cord the child may be destroyed if not born in time to breathe.

8th, The fœtus may be destroyed, from the premature expulsion of the cord. According to Carpuron apoplexy generally follows.

9th, The fœtus may be destroyed when the trunk of the body is expelled as far as the neck, and the head is long retained. Death is occasioned by pressure on the cord, or by the weight of the body pulling the neck, in other words, by strangulation.

10th, When the long diameter of the chest is presented to the short diameter of the pelvis, the shoulders are retained after the head is born; this gives rise to great difficulty in breathing, owing to the pressure made upon the chest.

11*th*, The *eleventh* is by far the most frequent cause of the death of the fœtus, viz. long and tedious labour after the discharge of the liquor amnii, and when the head of the child has been long retained in the os tincæ or pelvis. The child when born is observed to be insensible, a purple-coloured tumour may be observed on the vertex or occiput; the head is very much extended; the bones of the skull are depressed, and sometimes even fractured; and the eyes and face are of a livid hue.

12*th*, When delivery is sudden, and the contents of the womb are discharged at once, or *en bloc*, as the French call it.

13*th*, When the child, at the instant of birth, falls, head foremost, upon a hard substance it may be killed; this happens when the mother is in an erect position.

14*th*, The omitting to put a ligature upon the umbilical cord has been stated to be a cause of death of the fœtus. According to Carpuron, this mode of death is not to be admitted; he observes, "If we meet with a body of a newborn child pale, bloodless, of the colour of wax, and without a ligature on the cord, we should regard the hæmorrhage, which occasioned its death, after coming into the world, as an effect, not of omitting this ligature, but of the obstacles that hindered or suppressed the respiration and pulmonary circulation."

FINIS.